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Contents

	PAGE
Reliability of the Railways	399
Development Work by the User	399
Andrew Carnegie Relief Fund	400
The Nickel Position	400
Metro-Vick Activities in 1934	400
Costing for Vitreous Enamelling	401
Forthcoming Symposium on the Welding of Iron and Steel	404
The Position of Designer and Patternmaker in Relation to Foundry Practice	404
Permanent Set and Elastic Hysteresis in Cast Iron	405
Factors in the Economic Conduct of Vitreous Enamelling	407
Import of Unwrought Nickel	410
Book Review	410
Some Light Alloys Containing Nickel	411
Development of Glass Enamels	411
Cast Red Brass	411
Rapid Determination of Oxide in Molten Steel	412
This Week's News in Brief	413
Trade Talk	413
Company Meeting	413
Contracts Open	413
Company Reports	413
New Company	413
Personal	413
Obituary	413
Forthcoming Events	413
Raw Material Markets	414
A Study of Ground-Coat Enamels	414
Catalogue Received	406, 414

Reliability of the Railways

In recent years the Christmas holiday has become more and more an occasion for going away; the seaside holiday has become increasingly popular as a change from the family gathering at home, and in consequence a greatly increased demand upon the transport undertakings has arisen. The strain on the human internal organs resulting from the established ritual of gross over-eating and over-drinking at this time of the year is insignificant by comparison with the strain on the railway systems of this country during the few days immediately before and after Christmas Day. Without any thought for the intricate planning which lies behind the movement of every train, the British public descends in a mass upon a long-suffering organisation and demands to be taken hither and thither with the utmost speed and comfort. The railway organisations, as usual, rise to the occasion in a truly admirable manner, and succeed in conveying their ill-assorted and troublesome freight without delay and with a degree of reliability and punctuality greater than that to be found in any other form of transport.

British railways do indeed perform a service which is essential to the very existence of the nation; were the four main lines to cease operation at short notice, it is not too much to say that the country would be quite unable to carry on for more than a few days. As a form of transport they are still supreme. Road competition has its advantages for the door-to-door delivery of small consignments, but cannot compare with the railways for the bulk haulage of either freight or passengers. Even when faced with competition from within the gates, the steam locomotive still holds its own. Diesel power and electric traction have both made rapid strides within recent years, but the advancing design of the steam locomotive, despite the handicaps of limited loading gauge and axle-loads, has kept this form of traction well ahead of its rivals. The recent London to Leeds record serves as concrete evidence of the virile condition of modern steam traction, while, when the much longer non-stop runs and the increased weight of modern luxury trains are taken into consideration, it is clear that the present-day steam locomotive is far ahead of its predecessors.

These advances in design and performance have not been made without the co-operation of the metallurgist and the foundryman. Greatly improved and more reliable materials are of necessity required for the construction of the modern locomotive, and these demands have been adequately met from the metallurgical side. There is, however, still considerable scope for further development in the materials used in this field, but railway engineers are for obvious reasons conservative in their adoption of new and relatively untried materials. The case which has recently been put forward for the establishment of a national locomotive-testing station in this country, on the lines of the excellent French station at Vitry, shows that the railway companies are fully aware of the need for development work both on the design and materials side. If this very desirable project comes to fruition in the near future, a wide range of possibilities will be opened up for the investigation of such materials as the special and high-duty cast irons and the newer bearing-alloys under service conditions.

Development Work by the User

It is well known that the gap or time-lag which so often exists between the completion of a piece of research work and its adoption by the particular branch of industry concerned constitutes one of the most potent factors making for inefficiency in modern industry. In order to overcome this difficulty to some extent, a number of organisations have been set up, within both the research associations and the more progressive firms on the producing side of metallurgical industry, to cope with the development work necessary to secure the most advantageous and expeditious absorption of the results of research. A great deal of valuable work of this type is, of course, carried out by such bodies as the British Cast Iron Research Association, the British Non-Ferrous Metals Research Association, the organisations associated with the nickel, aluminium, copper and tin interests, and also by individual firms, but it is only rarely that these efforts meet with the full and informed support which they deserve from the using side of the industry. Improvements and developments in materials and processes are apt to get into production mainly as the result of a war of attrition, rather than as a consummation of research and development work actively desired by both parties. There are naturally exceptions to this dictum—large and successful firms who are always watchful for metallurgical

developments, and who are genuinely keen to back up the efforts of the producing concerns—but these still constitute but a small minority of the number of firms whose success and efficiency depend upon the employment of metallurgical products to the greatest advantage.

In the great majority of cases the disconcerting apathy which is displayed towards anything new or improved is to be attributed partly to an uninformed outlook and partly to inefficient organisation. Many of these user firms include in their activities the maintenance of a chemical and metallurgical laboratory, but the uses to which this department is put are often confined to the simple analysis and testing of supplies and the maintenance of works processes. The fault may perhaps lie with the mentality of the man at the head of the laboratory, or with the policy of the firm, but whatever the cause, this passive type of procedure is not likely to be of much benefit in increasing efficiency or reducing production costs. If the demands of present-day engineering designs and operating conditions are to be met, a much more active form of co-operation with the metallurgical industries is necessary. It will generally be found that those firms which have realised this necessity include in their organisation one or more competent metallurgists or metallurgical engineers who are made responsible for co-operating with the purely metallurgical development workers on the production side. A man of this type, capable of interpreting the most fundamental research work and at the same time fully conversant with the processes and needs of his particular firm, performs an invaluable duty in selecting and adapting the most appropriate developments. Pure research is outside the province of user firms, but its full and rapid exploitation is becoming increasingly necessary.

Andrew Carnegie Relief Fund

The Council of the Iron and Steel Institute are prepared to make annually a limited number of grants from the Research Fund founded by the late Mr. Andrew Carnegie in aid of metallurgical research work. The object of the scheme is not to facilitate ordinary collegiate studies, but to enable students, who have passed through a college curriculum or have been trained in industrial establishments, to conduct researches on problems of practical and scientific importance relating to the metallurgy of iron and steel and allied subjects. Candidates, who must be under 35 years of age, must apply before the end of next January on a special form to be obtained from the Secretary of the Institute.

The value of the grant will depend on the nature of the proposed research work, but the maximum amount granted in any one year will, as a rule, not exceed £100. The payment of the grant will be made in four equal instalments, the first being payable on the announcement of the award, and the following two subject to receiving a report on the progress of the work, either from the candidate or from his referees. The final instalment will not be paid until a considered report has been received, the maximum time allowed to candidates being two years from the date of the first announcement of the award. The Council may, at their discretion, award a further grant in aid of any particular research work, which seems to them sufficiently meritorious to justify further assistance.

The results of the research shall be communicated to the Iron and Steel Institute, which will have the right of priority of publication in full, and will bear the whole costs thereof. In considering the allocation of grants, the Council cannot pledge themselves to accept any particular proposal, but will be guided by the nature of the subjects proposed for investigation, giving preference to those which, in their judgment, appear to be of the most practical advantage to the iron and steel and allied industries.

The Nickel Position

BY "ONLOOKER."

In spite of the very low prices ruling for lead, zinc and copper, demand for all these metals is good and has, as a matter of fact, been excellent throughout the present year, while the outlook suggests that this happy state of affairs is likely to continue. What about nickel? Very similar conditions obtain as in the other metals, and the rate of use is very high, the producers being hard put to it from time to time to keep their customers going, for during 1934 demand has exceeded by far all the expectations formed in the closing months of 1933. Reference has been made to the favourable situation in lead, copper and zinc, but to a great extent this has been confined to conditions obtaining in this country, whereas demand for nickel has come from all round, Russia and Germany being prominent as buyers. Whether this remarkable increase in nickel usage is entirely due to the requirements of ordinary commercial undertakings is perhaps questionable, but whatever the cause may be, the fact remains that a rare lot of nickel is being bought just now.

As a matter of fact, nickel has come rather prominently to the front lately in another connection, for there is much talk of curtailment of copper, and as far as Canadian production is concerned the fortunes of the two metals are linked together. Cut down the output of copper and you immediately limit the amount of nickel available for use, so that it is not wonderful that amid the welter of reports in circulation on this vexed question of copper restriction the statement is being made that, whoever else cuts down, Canada will carry on as at present, at any rate as far as the tonnage of copper produced as a by-product of nickel is concerned. In a recent statement Mr. Robert Stanley, of the International Nickel Company, said that for every pound of nickel produced two pounds of copper are set free, so that some idea can be formed of what chances there are of getting copper output down.

In common with other commodities, nickel has suffered something of a setback in its rate of production during the past few years, for in 1929 the world total was about 54,000 tons while in 1930 there was not much falling off although the rate of consumption was obviously beginning to decline. In 1931, however, there was a marked change and the total came down to about 33,000 tons, the following year registering a sharp decline to only half this quantity. This proved to be the bottom of the curve, and in 1933 it was found necessary to speed up, and 40,000 tons was the world total, a figure which must have been surpassed this year. During this period of fluctuating outputs the production of New Caledonia has not changed much, the variation being from 3,000 tons to 5,000 tons, but Canada's contribution has altered considerably.

Just what tonnage of nickel the world can absorb must be a matter for conjecture, but since the end of the war, when the demand in connection with armaments ceased and the suppliers were obliged to look round for fresh fields to conquer, very considerable progress has been made, as a result of which this metal is now in keen demand in every direction. According to the American Bureau of Metal Statistics the sales of nickel in all forms by the International Nickel Company in 1929 amounted to about 62,000 short tons, while the same authority gives 37,000 short tons as last year's total, which was double as much as in 1932. The world's present-day capacity of production of nickel is probably about 100,000 tons per annum, and although consumption is still considerably short of this the day may come when it will be required.

Metro-Vick Activities in 1934

The Metropolitan-Vickers Electrical Company, Limited, in the course of their annual review of work and progress during 1934, point out that although the year has not seen any new records created in the size of turbine units or in their operating conditions, yet it is gratifying to record that the orders for new turbine generating plant show a substantial increase on last year whether treated on the basis of aggregate capacity or of the number of units. Of sets of 30,000-kw. capacity and over, six units were ordered, the largest individual unit being of 53,000 kw., for the Kansai Power Company, Japan. An order was received for three units each of 33,000-kw. capacity for the Victoria Falls & Transvaal Power Company for their Klip Power Station, and a set of 30,750 kw. was ordered by the Manchester Corporation. The year witnessed a substantial increase in the number of self-contained turbine sets ordered, ranging in capacity from 200 kw. to 5,000 kw.

Orders for large induction motors required for change of frequency, particularly for the North-Eastern, Midland and South Wales areas, have accounted for a portion of the output of large induction motors and have included a number of large winder motors for the Durham area. Frequency-change motors alone of over 250 h.p. in output have amounted to a total of over 26,000 h.p. Many large induction motors have been built for motor-generator sets for electric winder equipments for South Africa. Orders for rolling-mill motors for the home trade have also been numerous. Squirrel-cage motors up to 1,200 h.p. have been built during the year. A considerable number of large d.c. motors and generators forming part of motor-generator sets have been ordered or supplied during the year.

The demand for colliery transformers for installation underground continues. These fall into two classes:—(1) The medium capacity three-phase transformer (50 to 300 k.v.a.) for use in the non-danger zone of the mine, at a distance from the coal face, and (2) the small flameproof transformer for use at the coal face. A considerable number of orders for 5 k.v.a. single-phase flameproof colliery transformers have been executed. A further notable development is a 300-v.a. flameproof lighting transformer, of which a number are on order.

A large number of rolling mills have been equipped with power drive during the past year, the largest of which was supplied from a motor-generator set driven by a 7,000-h.p. synchronous induction motor. For the same works, there are on order two push-bench equipments for making tubes. One bench is driven by a 2,000-h.p. 150/300-r.p.m. motor, and the other by a 1,000-h.p. 150/400-r.p.m. motor. The motors are supplied from a motor-generator set driven by a 3,500-h.p. 11,000-volt synchronous motor.

A large reversing-mill equipment is on order for The Briton Ferry Steel Company, Limited, South Wales. This comprises a 2,900-h.p. mill motor, with peaks of 9,070 h.p. supplied from a steam-turbine-driven flywheel motor-generator set. Much attention has been paid to the subject of individually motor-driven live rollers, and apart from designing and supplying special motors for this type of drive, the firm has standardised control gear for them.

In connection with blast furnaces, the following equipments were supplied or ordered for this year:—Two 120-h.p. d.c. equipments to the orders of Messrs. Head, Wrightson & Company, for the Wellingborough works of the Stanton Iron Company; two equipments, each comprising an 80-h.p. d.c. motor and Ward-Leonard motor-generator set for Messrs. Stewarts and Lloyds, Limited, Corby; and a 75-h.p. d.c. hoist motor with bell and sounding-rod equipments for Colvilles, Limited. In connection with

(*Concluded on page* 413.)

Costing for Vitreous Enamelling*

By William Todd, of the Parkinson Stove Company, Limited

Introduction

At the outset, it should be made quite clear that in referring to a vitreous enamelling plant it is proposed to deal with a factory or works which may be defined as a group of shops or departments under one management, engaged in:—(1) the preparation of frits necessary for (2) the enamelling of sheet-iron and cast-iron components for domestic household appliances. Naturally if, as is the case with many firms, they purchase the frit ready for milling the costing system in these instances becomes somewhat simplified.

The varied character of enamelling work carried out by many jobbing firms in the industry, handling as they do comparatively small quantities of a multiplicity of shapes and types, often simultaneous with bulk quantities of what is termed "bread and butter" lines, demands a system of factory accounting which must be flexible. Their requirements are distinct from the plant operating as a process department, *i.e.*, a unit within a larger factory system finishing a standard line or lines of the company's products.

The present day keenness as regards competitive prices demands a closer examination of costs, indeed all factory expenditure. Gone are the days when one could assume that the old method of allowing an ample margin would enable one, on occasions, blindly to quote 1s. against a competitor's 1s. 1d. per piece—one must know definitely what that margin is, if it exists.

In the past one has inferred that the worker is entirely responsible for the comparatively low production and the resultant high costs—too little attention has been focussed upon what, it is suggested, is the real crux of the problem, namely, efficient organisation, equipment and methods. These, together with a remunerative incentive, would go far towards the attainment of our objective.

It is required to direct the spotlight of analysis on all problems affecting production; in other words, the development of an analytical mind would materially assist in the solution thereof.

Mr. J. E. Powell, in his book "The Output Problem," says:—

> "A full recognition of all the factors which enter into and affect production, will ensure a successful future. The old policy of exploiting labour in the direction of low wages is obsolete, and must give way to the more enlightened and more profitable exploitation of the possibilities of administration, organisation and methods, in the interests of low costs."

It is submitted that, despite the passing of a decade, there is still room for such exploitation in many factories, and in particular many of those engaged in the vitreous-enamelling industry.

Examining the pregnant possibilities that follow the submission of a quotation, one must assume the estimator has reviewed every expense likely to be incurred in the execution of the contract—labour, material, special fixtures, such as fusing pettits required only for the class of work contemplated, and sundry incidental charges. In the event of acceptance, the contractual obligation is, therefore, to execute the order regardless of whether an actual profit or loss is shown by the subsequent costs in relation to this specific contract. In many cases, no actual productive costs are taken out, so that the assumption that a profit has been made is, in fact, erroneous.

The cumulative effect of such a policy is obvious, and would result in an adverse balance being shown at the conclusion of the financial year. The term "ample margin" means inclusion of such high contingencies that, assuming more than average production losses occurred, the additional amount provided for would ensure a profit being obtained.

It is, of course, in order to allow, say, 5 per cent. for contingencies, which should be shown separate to the recognised margin permissible for profit, the point being that this should be specifically provided for. The main dangers to be guarded against here are:—(1) Should competition be keen, the business would in all probability go to the lowest tender, other factors, such as quality and delivery time, being equal; and (2) if practically monopoly conditions prevailed and undue advantage be taken of same, it may result in other firms being induced to enter the industry. There have been in recent times many such entrants into the vitreous-enamelling trade. Again, firms whose main business was not that of enamelling, have been compelled to engage upon the manufacture and application of enamels in order to reduce the cost of their finished products.

Works or Factory Costing

This represents the segregation of all expenditure incurred in the manufacture, and, when set out in predetermined columnar headings, provides an invaluable analysis of such outgoings. The details are obtained through the normal administrative channels, such as time sheets and piece-work dockets; the issue and progress through the works of materials is controlled by the necessary dockets, as is also the receipt of all purchased materials; these, together with stock records, are then translated by the costing department into monetary values, which are then ready for allocation in accordance with the prescribed system for that particular factory. Thus, the value of the cost allocation depends upon the accuracy of records obtained. These two factors may, therefore, be deemed to constitute factory accounting.

The purpose to which the factory management contemplate using the costs determines the standard of analysis to be adopted. They may be arranged in four main groups:—

(*a*) *Industrial.*—For the purpose of arranging wage rates and establishing industrial co-ordination.

(*b*) *Technical.*—For establishing productive efficiency.

(*c*) *Commercial.*—For fixation of selling prices.

(*d*) *Financial.*—For providing interim stock and work in progress values.

It is proposed briefly to touch upon (*a*), (*b*), (*d*), and devote the main attention to the section (*b*), "Technical."

Industrial

Whilst it is true, wage rates are determined in the main by collective bargaining between organised labour, as represented by the trade unions, and the employers, individually or as an association, it is not always appreciated that the accurate cost records can be used as an effective means of:—(1) Impressing the operatives and their representatives with the economic value upon which it is possible to obtain business; (2) the effect of demands for increased wage rates upon trading returns; (3) the reaction of high prices and unreliable delivery dates upon international and home markets; and (4) the influence of maximum output at minimum cost to all concerned in industry.

Again, absolute and complete knowledge of costs, and confidence in methods of costs computation are essential before one can embark upon a scheme of payment by results, or profit-sharing with labour.

Commercial

The necessity of fixing selling prices with due regard to the eventual production cost has generally been held to be responsible for the inauguration of a costing system. It often happens, however, that the ruling market prices determine the selling price obtainable—and it is then that an analysis of the production costs by the technician will indicate a line of development that will reduce cost of production and provide a reasonable margin of profit, hence the plea in the introduction to this article for the exploitation of methods of manufacture.

Everybody is familiar, even to-day, with the fact that the selling price is arrived at in a very haphazard manner; in many cases, the cost clerk visits the foreman and bases his cost upon the estimate of the latter—this, although his technical and practical knowledge may be very wide of the actual truth—in any case, he invariably adds a little on "for luck" just to cover himself—and being delightfully vague about financial details such as overheads, does not appreciate the combined effect upon the final monetary value of the workshop operations he controls. This represents a real danger. Other trades, such as printing and pottery, etc., have realised this, and put their houses in order. Recently there has been similar activity in the light-castings industry.

Financial

Accurate cost records can be utilised for presenting a statement of value of (1) stock held and (2) work in progress for interim profit and loss accounts, without resorting to the costly method of stocktaking at frequent intervals.

Technical

As one who is mainly concerned with achieving one of the many functions of works management, the author hopes he will be excused if he dwells unduly upon the technical use of costs. His apology is its extreme importance. It will be observed that he has previously stressed the vital necessity of exploring all avenues in the interests of low costs; here it is hoped to show the manner in which it is possible to use costs for the obtainment of production efficiency and the elimination of waste. It therefore follows that this application has an important bearing upon the system to be employed in the collation and tabulation of the administrative records from which the actual cost figures are extracted.

The technical use of costs should take a definite place in any manufacturing policy. The inauguration and subsequent running of an efficient cost system is always expensive, especially if there has been a total absence of control previously. If no positive policy exists, or there is any suggestion of vacillation, either in regard to matters requiring decision or action, then any system will be expensive, and the lack of an effective system will be equally disastrous.

Initially, an investigation should be held to ascertain the faults and weaknesses of existing policy—system or methods; the results would materially assist in forming the basis upon which the new system should be installed and maintained at a minimum running cost. There must be economy in the cost department as well as in the manufacturing processes. In regard to control, this has always been, and will continue to be, a debatable point. Should the cost department be under the control of the works manager, commercial manager, or an independent cost accountant? It does, of course, pre-suppose a factory requiring the services of three such officials. Mr. E. T. Elbourne, in his book "Costing Problem," says:—

> "If costs were only useful commercially and financially, the case for full control by accountants would be very strong; but when the not less important considerations of industrial and technical uses are taken into account it becomes

* A Paper read before The Midland Section of the Institute of Vitreous Enamellers in Birmingham, Mr. J. W. Gardom presiding.

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evident that the technical manager ought to determine the main issues. He need not be an expert factory accountant to be properly responsible for factory accounts any more than an engineer need be an expert patternmaker to control patternshop practice. His technical knowledge gives him an unassailable advantage in settling the details and methods of collecting administrative records, and he should find no difficulty in following the records and accounts through to the financial stage of unit production costs."

A personal view is, where possible, the cost accountant should be in complete control of the cost department and independent of either the works or commercial manager; the policy affecting margin of profit according to class of goods, whether selling price is determined by market rulings or not, is usually enunciated by the managing director. There must of necessity be complete co-ordination between all three.

In the event of there being any doubt having regard to the size of the works, then the control should be vested in the works management, as should also be the buying department: this may appear incidental, but nevertheless important; the buyer, unless a trained technician, should be under the control of the technical manager, so as to have the advantage of his practical knowledge.

Works Costing

Costs can be arranged under two headings:—(1) Costs taken out at a given date, *i.e.*, *test costs*, and (2) costs taken out over a stated period, *i.e.*, *actual costs*.

Test Costs, or better known as estimated costs, are, of course, required for fixation of prices prior to the submission of a tender or quotation. Where, of course, it is permissible, actual productive times and amounts of material previously measured should be utilised.

Actual or Eventual Costs (known by some as "period costing"), accurately collated and tabulated, are of immense value to the works management, because they indicate fluctuations of expenditure in time and material, serve as a comparison with the estimated costs, enables investigation and subsequent action by the technical staff.

The three main sections are:—Material; labour (known as direct costs); and cost of upkeep or establishment charges (known as overhead or indirect costs).

Material and Labour

This, of course, must include all material actually required in the manufacture of the article. It may, however, be deemed necessary to provide a column for indirect material, such as that required to provide templates, fusing pettits, fixtures, stencils, gloves, nozzles, overalls, etc., especially in the event of such a job being of the non-recurring type.

Again, an order may be repeated at intervals. A decision must then be taken as to how far it is possible to apportion such expense over a period—it may be considered an advantage to charge such special equipment on the first order, at the same time pointing out to the potential customer that a reduction in price will be obtained when further orders are placed—often a persuasive proposition in securing the current business, and obtaining repeat orders.

Take, for example, sheet iron enamelling, great economy can be obtained by predetermining the size of sheet to be used in either cutting out on the guillotine to shape and size required, or the size of blank to be used in the press for, say, cutting and raising operations. Attention should be given to the fact that it may be wise to pay the extra charge demanded by the sheet manufacturers for supplying sheets cut to a specific width and length—removing all grip marks—this charge is usually in the region of £1 per ton, and has the advantage of eliminating all scrap on guillotine operations.

Again, consideration must be given to the gauge of metal required for pressings, despite customer's specifications—the enameller who fabricates his own material should be in a position to advise his customer as to the gauge which would be most suitable—and this comes within the category of "service to customer."

Broadly speaking, a pressing having a "deep" draw, can be made from a lighter gauge than a similar component having a "shallow" draw; again, due regard must be had as to whether plates can be flanged—or made with folded edges on all sides—and, thus strengthened, they will resist distortion.

Similarly, the sheet area of pressing determines the gauge, *e.g.*, a plate 12 in. by 20 in. can be made from 22 or 24 gauge—one measuring 24 in. by 30 in. may have to be made from 18 or 20 gauge metal.

It has been frequently stated that it is more economical to use a high grade sheet made from ingot iron as compared with ordinary P.R.C.A. sheets, although there may be varied views in this respect. Experience has prompted manufacturers to bring out a competitive grade of special enamelling quality sheet. The author has conducted tests over a period of several months, and the conclusion was that for certain classes of work the lower-priced sheet graded for enamelling was the more economical, and the high-grade sheet was only justified on irregular shapes, especially when they were required in good quality white porcelain finish.

Castings

The introduction of cast iron to the wet process has given rise to more technical complications than sheet iron. As this is to form the subject of a Paper later in the session, it is not proposed to trespass beyond briefly stating that the castings must be free from dirt and slag—have uniform thickness of section, no sharp edges—radii wherever possible.

Frit

It is assumed the system covers a firm who have decided that it is more profitable for them to manufacture than to buy frit, and have installed the necessary plant complete with laboratory and personnel, the personnel to include chemists who would control the various processes.

The mixing, melting and mill rooms work to definite formulæ, strictly supervised by the laboratory—all ingredients, such as borax, felspar, cryolite, flint, soda, representing refractories and fluxes, together with colouring oxides, clay and water (usually classified as mill additions), must be carefully weighed and controlled at each and every process stage.

(*a*) *Dry weight.*—Frit with ascertained loss during melting, plus mill additions, less water.

(*b*) *Wet weight.*

Labour

The cost of labour is, like material, divided into two classes:—(*a*) Direct or productive labour, and (*b*) indirect or non-productive labour.

Under the heading "Direct Labour" it is advisable to allocate, where possible, all labour employed in processing the enamel ware. If, for example, it were deemed necessary to introduce a labourer as an additional fuser's mate, owing to the nature of the product being handled, the system employed should be such as to ensure that man's time being charged to actual production; and not, as is often the case, remain as an indirect or "on-cost" charge. The best policy is to insist upon indirect labour charges being maintained at the lowest possible level, consistent with efficiency. Under this heading would be shown all labour engaged in the preparation of the ware, *i.e.*, in the case of:—

Cast Iron.—Annealing, sandblasting, interim inspection, filling, spraying and fusing.

Sheet Iron.—Degreasing or grease burning, pickling, swilling or dipping, spraying, brushing, tipping, transferring and fusing.

The indirect or non-productive labour covers:—Inspection, clerical labour, supervision, labouring, and are included for accounting purposes in the shop overheads.

Establishment or Overhead Charges.—This category includes all other expenditure connected with manufacture, none of which can be directly charged to a specific job, and includes various items which may be allocated under two headings:—

(1) *Factory Overheads.*—Including rent, taxes, insurance, depreciation, repairs, salaries (including supervisory staff), power, lighting, indirect material, consumable and sundry stores, etc.

(2) *General Overheads.*—Which includes all other expenses, not applicable to actual manufacture—selling, distributive and administrative.

The efforts made to obtain correct distribution of factory overhead expenses has seen the evolution of many systems. It is now generally recognised that the old method of applying a percentage to the direct labour charge is incorrect, and the better method is to utilise the "man-hour" basis, where labour may be graded as hand labour, *i.e.*, the total hours divided into the total overhead expense gives a rate per hr., which rate, multiplied by the hours spent on a job, gives the overhead expenses chargeable to that job. In a plant or section thereof, where machines are the producing unit, the distribution must be on the basis of the "machine hour."

This is the method recommended by the committee on commercial efficiency, set up by the Federation of British Industries in September, 1918.

There has now been obtained all the information necessary to compute the cost per piece. One therefore sets off the total costs as shown against the total output for the period under review, whether it is one, three or six months, as may be determined by the policy of the direction.

The result obtained may be expressed:—(*a*) Size of piece, *i.e.*, superficial enamelled ware area set out in value per sq. ft. Whilst this is comparatively easy in the case of sheet iron, a difficulty arises in regard to:—(*b*) castings. Owing to the weight factor, here it may be considered advisable to express our values per lb. of material, and (*c*) where it is customary to process sets of components such as stove parts, it may be possible to set up a value per set, but as the question of replacement parts arises this inevitably leads to a further segregation of values per component.

The first-named method of a price per sq. ft. is preferable, even although initially it involves a great deal of calculation. This work need not be repeated if use is made of tabulating the results. Again, it is possible to simplify the work by the utilisation of curves on squared paper—this method enables reasonably accurate tabulation to be made within three or four points fixed. The use of calculating machines can also be taken into account. Lastly, the important essential is to record the basis on which the tables have been built up.

Time Studies

In all such operations as sand-blasting of castings, spraying and swilling, the author would advocate the introduction of time and motion study. The observations thus set up will materially assist in revealing reasons for lost or idle time, due in many cases to causes beyond the operator's control. The action taken by the management in eliminating such lost time creates an appreciative spirit amongst the more enlightened class of labour, including union representatives. In conclusion, it is hoped the day will not be far distant when the vitreous-enamelling industry, especially the general or jobbing firms, will realise in their own interests that there is a need for a uniform system of

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costing. What was found possible by the printing, pottery and rubber traders several years ago is essential to enamellers—the former saw the futility of haphazard methods, and it is hoped they will do likewise. Finally, it is suggested there is no better medium than that of The Institute of Vitreous Enamellers.

DISCUSSION

The CHAIRMAN (Mr. J. W. Gardom) informed the members of the decision of the General Council that, for the time being, all sections would be controlled by the Council. This was decided on grounds of policy, which they would appreciate, seeing that the Institute had only recently been inaugurated. Consequently General Council members would exercise control in their respective areas for the present year, but what followed would be decided at the next annual general meeting. As things were, members could take it that at these monthly lecture meetings the Section was also in Committee, and if any of them had any matter to raise, it would be quite in order to do so.

Mr. Gardom also said that the majority of institutes put aside the question of costings, although it was most important for the proper and businesslike conduct of any branch of industry. Concerns which ought to have a system of costings often delayed its adoption until it was forced upon them more or less, and he thought that it spoke well for the activity of the Institute that this question was among the first to have been tackled.

Effect of Equipment on Costs

MR. J. T. GRAY (London) said, having a fairly broad experience with a considerable number of plants throughout the country, he had found that production costings were affected by equipment—he was referring purely to enamelling departments—more than any other item. He did not necessarily mean among heavy expensive equipment such as furnaces, mills, and so forth; but to the smaller classes of equipment and the methods of handling work from one section of the plant to another. He had seen cases where production costs in one operation had been practically doubled, or where it could have been reduced by half by utilising a suitable type of equipment. As to what was the best system of costing from the aspect of overheads, did the lecturer consider that the majority of overhead costs should be computed from labour costs, and not so much from costs of materials? Allusion had been made to the purchase of metal sheet re-sheared and re-squared costing approximately £1 per ton extra, and he inquired would not this practice probably help some enamellers in tracing a bad batch from the sheetmaker on account of the sheets being under better control. Such sheets cut to size would be required for a certain job at a given time; whereas in most cases they bought in sheet tonnages, and the sheets were used down to, say, the last two tons, when another consignment was placed on top. Hence, by the time a bad batch was discovered, there was no knowing whether the sheets concerned had been in store six months or six years.

Machine Hour Rate as Basis

In reply, MR. TODD said he understood that the question was whether he agreed that the major percentage of overheads should be applied to labour and a lesser percentage on material. He agreed that where the percentage method was employed this allocation was substantially correct. In apportioning overhead charges, a definite figure ought to be allocated for handling; it might be 5 to 10 per cent. according to the nature of the material handled. With regard to the percentage or amount to be applied, if the system was a percentage one then the only satisfactory way was to apply it entirely to the direct labour cost. He would suggest that it was disastrous to take foundry overheads as a fixed percentage applicable to all departments. It was worth while, no matter how small the works, to departmentalise for apportioning overheads, and if they were still bound to use percentages, they would find that variations occurred of from 45 to 150 per cent. It was obvious that if they had a factory overhead's rate expressed as 100 per cent. on labour, that they would be penalising certain departments while others would be getting away with some something which should be allocated to them. A much better basis where machines were in use was to work by machine-hour rate, and in other departments by a man-hour rate. In this connection he strongly recommended the use of a time-rate rather than a monetary rate. This was the system which was being introduced into the works with which he was connected. As to the purchase of sheets, the matter of grip marks was important. In a certain case where a bad batch was found it was alleged that there had been some parsimony in the use of material, and that the grip marks had never been sheared off. At their factory it had been decided to buy sheets free from grip marks to avoid any such contingency; they would not be cut to the exact size, but so that there would be no grips left when the sheets were guillotined.

Mass Production and Jobbing Shops

MR. F. B. SELLARS remarked that he particularly noticed his contention that the costing of jobbing work in the enamelling shops, and the costing of a shop which was but one of a line of production shops, must necessarily be quite a different matter. He agreed that this was so in detail, but by no means so in principle. He assumed that the lecturer had in mind that the presentation of detail to works managers might possibly be in slightly different form in each case. For instance, a jobbing shop would be interested in its output per hour of enamelling ware; but, taking a department for domestic stoves, then the works manager would be more interested in output in terms of sets of stoves. Hence this splitting up of the problem was of some value, and particularly so on the question of time allowed. An experiment had taken place at the factory where he was engaged similar to that mentioned by Mr. Todd, and as a result they had definitely gone away from the cost per square foot to the cost per allowed hour on an operation. However, they still kept the cost per square foot as a check figure on the cost per allowed hour, and they were very interested to see how much the proportion per square foot on the cost of iron and steel was to the allowed hour.

A Curious Comparison

Generally, in his particular line, which dealt largely with cast iron, the weight of a component—as apart from the increased time allowed to the fuser and the sprayer, etc.—did not interest them. But, obviously, all the increased weight in the furnace, and in the handling for pickling and sand blasting and other operations, were factors which affected costs, particularly in loading. To carry Mr. Todd's point a little further, he was impressed by a case when comparing two separate costs, curiously enough in two separate factories. He found that the output on an oven, engaged upon a particular class of work, was roughly 50 per cent. greater in one factory than the other. There was extra labour in the first case, in which the oven possibly cost 10s. an hour to run, against a reduction of 1s. 6d. an hour in the other instance. They themselves arrived at their figures by the system of allowed hours in costing, which was the line Mr. Todd was taking. With regard to the relation of cost accountants to commercial or works managers, he thought the first-named were best used as separate entities. For example, if a cost accountant was under the control of one or the other, he was inclined not to be so frank, and there were times when he must disagree with people. Works managers were very definitely bound by production and production facilities. Take, for example, the question of using cast iron and steel, when at times the cost accountant could tell the selling side to concentrate on steel because they had "a bottle neck on sand blasting." It could be made very useful if the use of facilities on various operations were expressed in terms of allowed hours, and the residual load and orders also expressed in this way. It would prevent overtime and encourage the engagement of labour prior to a big load being dropped on to the works manager before he was ready for it.

Pettits as Plant

MR. B. B. KENT said that he rather differed on two points. Mr. Todd had said that pettit bars should be put down as incidental expenses, so he understood; but he maintained that it should be a capital charge on plant. They did not wear out at all quickly, and, moreover, there was an allowance for depreciation of plant of 10 per cent., which should cover the cost of operations so far as pettit bars were concerned. As to mixing sheets, the lecturer mentioned that he used high-grade sheets for white work and cheap ones for mottled enamelling; but he supposed that even in the most careful works it only needed one or two wrong batches to get through and the cheap sheets, whether white or mottled, would be found to be covered with blemishes and so swallow up all the saving made on the grading of sheets. To safeguard anyone against cutting up the cheaper sheets for white work—and there were not such a large proportion done in white—some other method should be adopted.

Separation of Sheets

MR. TODD, in reply, said it was a question of organisation. At their works they had found no difficulty in keeping high-grade sheets separate from other grades. They had tried three grades: the high grade which was manufactured from ingot iron; the ordinary common sheets costing about £11 to £12 per ton, and the competitive grades of enamelling iron sheets which fluctuated from £16 to £18—he quoted broad figures for obvious reasons. It was this latter class to which he referred as being specially prepared for enamelling; the middle class was the one which they found giving the best results for the lines indicated. Although there was a danger of mixing sheets, he suggested that they should not be led into the idea of accepting it as being inevitable; it was mainly a question of separating or segregating them according to the types of work to be done. Incidentally, he must admit that they had found some difficulty in carrying out tests, because there were three grades going through the works at the same time. However, accuracy of the figures ultimately obtained were ensured beyond doubt, for each part was stamped for this purpose. While they could not afford to throw money away, it was no use arriving at a false conclusion, wasting money and material, and then having to start over again. In actual production they did not repeat that method, and depended on good organisation to ensure that the proper sheets were used for specific purposes and jobs. Regarding pettit bars, he agreed with Mr. Kent, and said his object was to emphasise costing on non-recurring jobs. If they spent a substantial sum on equipment for a special job, and the customer never came back or they found someone undercutting them, the loss could not be recovered unless it was provided for in the costings initially.

Plant Obsolescence

MR. MILESON urged that one matter which the Institute ought to give major consideration to in dealing with the question of costs was the policy of the exploitation of plant. One firm enamelling sheets worked their plant 16 hours a day, and others 9 hours or so, with the inevitable closing down. He suggested that this was a fatuous policy, which ultimately led to premature obsolescence.

(*Concluded on page* 410.)

Forthcoming Symposium on the Welding of Iron and Steel

ORGANISED BY THE IRON AND STEEL INSTITUTE

From time to time, the increase in use and importance of the application of welding to construction of all kinds has attracted the attention of responsible bodies in this country, including that of the Department of Scientific and Industrial Research. It has become a matter of national importance that every opportunity shall be given to foster the art of welding, to encourage worthy schemes of research and, as far as possible, to avoid overlapping of research effort. It has been suggested that, as a first step, it would be desirable to arrange for a symposium of technical Papers, with the object of ascertaining and reviewing the present position. Accordingly, at the suggestion of the Department of Scientific and Industrial Research, and after careful consideration, the Council of the Iron and Steel Institute have decided to hold a Symposium on the Welding of Iron and Steel, to take place on Thursday and Friday, May 2 and 3, 1935, in conjunction with the annual meeting of the Iron and Steel Institute, which will be begun on Wednesday, May 1, 1935. The Symposium will be held in the Lecture Theatre of the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, by kind permission of the Council of that body.

In view of the national importance of the subject, the Council of the Iron and Steel Institute considered it essential that other societies and technical institutions directly concerned should be invited to co-operate. They accordingly approached the Councils of the following societies, and are pleased to state that their complete co-operation has been assured:—Institution of Automobile Engineers, British Iron and Steel Federation, British Steelwork Association, Institution of Civil Engineers, Institution of Electrical Engineers, Institution of Engineers and Shipbuilders in Scotland, Institute of Marine Engineers, Institution of Mechanical Engineers, Institution of Naval Architects, North-East Coast Institution of Engineers and Shipbuilders, South Wales Institute of Engineers, Institution of Structural Engineers, and the Institution of Welding Engineers. The Symposium will therefore be held under the patronage of these societies.

The general objects of the Symposium will be: (*a*) To review the position of welding in all its industrial aspects, both in Great Britain and in other countries; (*b*) to obtain knowledge of the problems encountered in welding as employed by the various industries in Great Britain and in other countries; (*c*) to reveal what research work has been or is being undertaken and, arising out of the above; and (*d*) to consider the advisability of taking steps to co-ordinate research work and to stimulate and guide future research, possibly with a view to formulating a national scheme.

It is intended to print Papers which are presented at the Symposium as well as the resulting discussions, etc., and to issue the proceedings as a bound volume. Advance copies will be available for use at the Symposium. At the conclusion a critical summary will be prepared, and it is anticipated that this will also contain suggestions for future action. A detailed scheme of organisation and a list of Papers to be invited have been prepared, and copies of these are available. A detailed programme will be issued at a later date.

The Committee appointed by the Council of the Iron and Steel Institute to make the arrangements for organising the Symposium and to collaborate for this purpose with representatives from the societies and technical institutions mentioned above, is as follows:—Sir Harold Carpenter, F.R.S. (chairman) (President-Elect of the Iron and Steel Institute, President of the Institution of Mining and Metallurgy, Professor of Metallurgy of the Royal School of Mines, Imperial College of Science and Technology); Dr. H. J. Gough, M.B.E., F.R.S., M.I.Mech.E. (Superintendent of Engineering Department, the National Physical Laboratory); Dr. W. H. Hatfield (Vice-President of the Iron and Steel Institute, Director of Research at the Brown-Firth Research Laboratories and director of Messrs. Thomas Firth & John Brown, Limited); Mr. James Henderson (honorary treasurer of the Iron and Steel Institute, President of the British Iron and Steel Federation, director of the United Steel Companies, Limited); Dr. A. M'Cance (member of Council of the Iron and Steel Institute, director of Messrs. Colvilles, Limited); Dr. T. Swinden (Director of Research, the United Steel Companies, Limited, director of Messrs. Samuel Fox & Company, Limited); and Mr. B. Talbot, M.I.Mech.E. (Past-President of the Iron and Steel Institute and of the National Federation of Iron and Steel Manufacturers, deputy chairman and managing director of the Cargo Fleet Iron Company, Limited).

Scheme of Organisation

GROUP 1.—*Present-Day Practice and Problems of Welding in the Engineering Industries.*—Sub-groups:—(*a*) Aeronautical industry; (*b*) agricultural engineering industry; (*c*) automobile industry; (*d*) chain manufacture; (*e*) electrical, heavy engineering and machinery manufacturing industries (including marine engineering); (*f*) pressure vessels (including boilers, pipe lines, tubes, tanks and vessels for use at high temperatures and pressures); (*g*) railway material; (*h*) shipbuilding; and (*j*) structural and bridge engineering.

GROUP 2.—*Welding Practice and Technique.*—To include Papers on the following subjects:—(*a*) Influence of fine beads; (*b*) layer welding and bead welding; (*c*) methods for vertical and overhead welding; and (*d*) relieving of stress and methods of avoiding distortion of welded structures.

GROUP 3.—*The Metallurgy of Welding.*—To include Papers on the following subjects:—(*a*) The absorption and evolution of gases during welding and their effects; (*b*) the chemical composition of the rod and the welded material and changes in composition on welding; (*c*) covering for rods; and (*d*) welding of special steels.

GROUP 4.—*Specification, Testing and Safety Aspects of Welding.*—To include Papers on the following subjects:—(*a*) The inspection of welds; (*b*) methods of testing (fatigue strength of welds; fatigue strength of welds and its relation to impact values and ductility, residual stresses and changes after welding); (*c*) safety aspects of welding; and (*d*) welding specifications.

GROUP 5.—*Current Research Projects in Welding.*—Sub-groups:—(*a*) Government research; (*b*) research by technical institutes; and (*c*) research by industrial companies.

In addition to Papers from authors in Great Britain, it is hoped to obtain contributions from other countries, including the following:—Australia, Czecho-Slovakia, Belgium, Canada, France, Germany, Italy, Norway, Poland, Sweden, Switzerland, and the United States of America.

The secretary, Mr. K. Headlam-Morley, secretary of the Iron and Steel Institute, 28, Victoria Street, London, S.W.1, will be glad to supply further information about the Symposium, and also to receive offers, suggestions, to contribute Papers and applications to take part in the proceedings.

HERR KRUPP VON BOHLEN has resigned the leadership of German industry, and Dr. Schacht has requested the leader of the Reich's Economic Chamber, Herr Ewald Hector, to take over Herr Krupp's place. It is understood that Herr Krupp resigned in order to be able to devote himself to the management of his own firm in view of the re-armament of Germany.

The Position of Designer and Patternmaker in Relation to Foundry Practice

Several points of a practical character were brought out in the discussion of Mr. A. L. Mortimer's Paper on "The Position of Designer and Patternmaker in Relation to Foundry Practice," which was printed in our issue of November 22, 1934.

The BRANCH-PRESIDENT (Mr. H. Hurst), in opening the discussion, said that they had now listened to Mr. Mortimer giving his Paper for which he was awarded the Surtees Gold Medal in the early part of the year. The Paper was excellent and well worthy of the award. He extended congratulations to Mr. Mortimer, and hoped that it would be an incentive to him to prepare other Papers to be read at the Branch meetings.

MR. MORTIMER pointed out that the general medium throughout the shop was oil sand. A special mixture could, as suggested, have been made up, but that would have meant a departure from the ordinary procedure of the shop, and that was to be avoided.

MR. A. MARSHALL said that, in regard to the plate, ¼ in. in thickness, which had been shown, he would have made a pattern and corebox for the job, as he considered it would have been cheaper than sweeping up. In the case of the plate with a flange, he would like to know if it could have been cut.

MR. MORTIMER, in answer, said that he always tried as far as possible to make a pattern and corebox, but he had to deal with patterns as they were sent to the foundry. He had emphasised in the Paper that he had no desire to usurp the patternmaker's work. He agreed that any job where 18 off were required, a pattern and corebox should be made suitable to the job.

MR. M. RUSSELL, referring to the plates and covers mentioned, said if that job had been offered to the Falkirk district, a stucco block would have been struck up.

MR. MORTIMER agreed with Mr. Russell that the makeshift job with the cover was all wrong, but the pattern was sent to the foundry in that condition, and they had to make the best they could of it.

MR. R. LIDDLE said that recently he had a job very much like the cover Mr. Mortimer had shown them. Like the author, he had to make the particular job with the tackle and plant available. In the job he was referring to, a difficulty was presented by a joint with a 3-in. bevel, and he found the corebox of little use. After all consideration, the patternshop and foundry could not see what would happen, but eventually they made a false mould. He agreed with Mr. Mortimer's methods with the plate and cover. It would be realised from the illustration that it would be very difficult to build up wood to that thickness.

The PRESIDENT asked what was the use of the four slots in the plate of a moulding machine. Mr. Mortimer had referred to the making of nozzle plates upside down, so as to get them accurate. He made large numbers of such nozzles on machines with the four slots in the table. MR. HURST then explained by means of blackboard sketches his method of moulding nozzle plates to very narrow limits, after which the PRESIDENT proposed a vote of thanks to the lecturer.

MARINE ENGINEERS and other visitors inspected at the works of Messrs. Parsons Marine Steam Turbine Company, Limited, Newcastle-upon-Tyne, recently, the new unit which this firm has produced to meet the requirements of a suitable marine steam turbine for cargo vessels. The new engine, which is called the "Simplex Unit," has been specially developed for cargo boats of small powers, such as tramp steamers of from 1,500 to 2,000 s.h.p.

Permanent Set and Elastic Hysteresis in Cast Iron

By J. E. Hurst, Vice-President, Institute of British Foundrymen

It is known that in materials for stresses below what is usually regarded as the elastic limits the relation between stress and strain is not strictly linear. In the case of steel for all practical purposes, this relationship is sufficiently near linear, but in the case of ordinary cast iron the departure from the linear relationship is of quite a substantial order. In the case of the gradual application followed by the gradual removal of stress, it has been shown that there is a lag in the diminution of strain, so that, when the stress/strain diagram is drawn for the complete cycle, it encloses a loop, the width of which at any given stress is the difference of strain between the loading and unloading curve. This phenomenon is referred to as elastic hysteresis and the loop diagram as the hysteresis diagram. The lag in the diminution of strain is accompanied by the absorption of energy, some of which is apparent as heat, and the enclosed area of the hysteresis loop is proportional to this energy. In the case of cycles of fluctuating stress, this lag in strain, or hysteresis, may cause a material at comparatively low stresses to accumulate considerable strains, and this phenomenon has been used as the basis of the explanation of fracture under repeated fluctuation of stress.

Hysteresis in Overstrain

A typical hysteresis loop for steel is illustrated in Fig. 1. The vertical width AB for zero strain

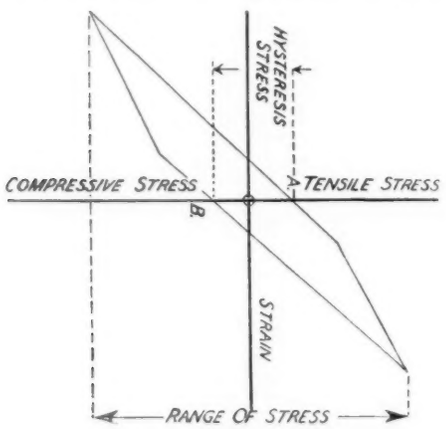

FIG. 1.

in the case of steel was found to be about 1/20 a ton per sq. in., when the total range of stress to which the specimen was subjected was 17 tons per sq. in., or 340 times AB (Hopkinson and Williamson, Proc. Royal Society, November 21, 1912). This phenomenon has been studied extensively in the case of steels. Rowell has found that the area of the hysteresis curve for annealed mild steel is practically the same at a speed of reversal of 67 cycles per sec., as in the case of a static experiment, and that the hysteresis in a hard-drawn steel is very much less than in an annealed steel. Also, that at a moderate temperature, such as 300 deg. C., the hysteresis increases and is much greater at slow speeds on stress reversal than at high speeds. The slow speeds of reversal, it is considered, allow of the material having more time to "flow." In the case of annealed steel, the "flow" at high temperatures is much less than in the case of unannealed material (Proc. Royal Soc., Series A., Vols. 89 and 91). It is also known that some of the strain taking place in a material previously subjected to straining action develops slowly by "creeping," and also that strains, or part of them, change in a similar way some time after the removal of the load. This property of temporary strain has been referred to also as hysteresis, and it is discussed by Morley under the heading "Hysteresis in Overstrain."* It is by no means certain that the phenomenon is associated only with overstrain, and certainly, in the case of cast iron, the experimental work to follow shows that such hysteresis can be detected with very low stress values.

Hysteresis and Plastic Deformation

Whether or not these hysteresis phenomena are different in character from the plastic deformation which occurs at the higher stress values in excess of the elastic limit is not known. They have been studied extensively in connection with a number of materials and their relation to fatigue failure; but very little work appears to have been done in connection with cast iron. They are probably of very great importance in considerations of the behaviour of cast iron in quite a number of industrial applications.

The experimental investigations described have been made using annular ring-form specimens of the type used for the commercial testing of cast iron in accordance with the requirements of B.S.I. specifications 5004 and 4K6 for aircraft material. This form of specimen and test lends itself admirably to the comparative investigation of these phenomena, as it is possible to obtain a high degree of dimensional accuracy in the specimens and a high degree of accuracy in the measurement of the deflections (strains) and the load values (stresses).

TABLE III.—*Gap of Change Dimension.*

Sample.	Gap released. Ins.	Gap after squeezing closed. Ins.	Change. Ins.	Per-centage change.
(*a*) No. 6	0.426	0.378	− 0.048	11.3
(*b*) No. 6	0.422	0.378	− 0.044	10.4
(*c*) No. 6	0.434	0.414	− 0.020	4.6

Permanent Set

In this investigation a comparative study of the behaviour of three different specimens of cast iron was undertaken with a view to exploring their characteristics in relation to these phenomena at low-stress values. For the purpose of the investigations a series of test-rings were machined from:—(*a*) A sand-cast annealed (stabilised) motor-car engine cylinder barrel; (*b*) an "as-cast" motor-car engine cylinder barrel, and (*c*) a centrifugal casting of drum form of the same diameter and radial thickness as specimens (*a*) and (*b*). The chemical analyses of these three materials are given in Table I:—

The sand castings were made in dry-sand moulds and the annealed or stabilised specimen (*a*) was submitted to a treatment at 500 deg. C. followed by slow cooling. The centrifugal casting was made by casting in a metal mould at a temperature on the internal surface of approximately 550 deg. C., and as in the case of the "as-cast" specimen was not subjected to any kind of heat-treatment whatsoever after casting. Six test-rings were machined from each of the sand-cast cylinders, commencing No. 1 from the mouth end and in the case of the centrifugal casting twelve rings were machined, commencing No. 1 from the mouth end. Only half the barrels were used in the case of the sand castings and the test-rings were all approximately identical in size, as can be seen from the dimensions recorded in Table II. The test-rings No. 6, that is, from approximately the middle of the length of the castings, were primarily tested for the usual mechanical properties of EN value and tensile strength in the manner laid down in the specifications referred to above. These results are tabulated in Table II.

The difference in loss between the two sand-cast specimens is not great and the centrifugal specimen has lost considerably less.

TABLE I.—*Chemical Analyses.*

Sample.	T.C.	C.C.	Gr.	Si.	Mn.	P.	Cr.
(*a*) Sand cast, stabilised	3.28	0.80	2.48	1.60	0.95	0.37	0.23
(*b*) "As-cast	3.06	0.66	2.40	1.64	0.78	0.36	0.09
(*c*) Centrifugal casting	3.45	0.64	2.81	2.46	1.12	0.70	0.25

TABLE II.—*Dimensional Comparisons of Mechanical Properties.*

Specimen.	Gap as cut. Ins.	Gap released. Ins.	Increment of gap. Ins.	Dia. uncut. Ins.	Dia. cut. Ins.	*b*. Ins.
(*a*) No. 6	0.426	0.426	± 0.000	4.53	4.39	0.248
(*b*) No. 6	0.426	0.422	− 0.004	4.53	4.39	0.252
(*c*) No. 6	0.426	0.434	+ 0.008	4.53	4.39	0.253

Specimen.	*t*. Ins.	Gap.* Ins.	Lbs.	EN. Lbs. per in.^{2} × 10.^{6}	Lbs.	Tensile. Tons per in.^{2}
(*a*) No. 6	0.143	0.378	11.55	17.32	28.3	20.9
(*b*) No. 6	0.143	0.378	12.2	18.05	26.2	19.4
(*c*) No. 6	0.142	0.414	12.4	17.11	24.0	18.0

* The gap measurements for the EN value were taken after the rings had been squeezed closed, once for the "Diameter Cut" measurement and twice for the EN determination, a total of three times. As a result of this squeezing the gap changed from the original released gap dimension and in all cases became slightly less as is shown in Table III.

Reference should be made also to the manifestation of internal stress as revealed by the increment of gap. The sand-cast specimens show nil in the annealed and a negative increment (closing) in the "as-cast specimen," whilst the centrifugal specimen shows a postive increment of quite substantial magnitude.

These tests were conducted on August 4, 1932, at 4.30 p.m. The rings were allowed to stand 24 hrs. until 4.30 p.m. on August 5, when the gaps were again measured. During this period the gaps have apparently undergone a partial recovery, to an extent as shown by Table IV.

TABLE IV.—*Influence of Time on Gap Dimensions.*

Sample.	Gap released. Ins.	Gap after squeezing. Ins.	Gap after standing 24 hrs. Ins.	Recovery.
(*a*) No. 6	0.426	0.378	0.386	+ 0.008
(*b*) No. 6	0.422	0.378	0.384	+ 0.006
(*c*) No. 6	0.434	0.414	0.416	+ 0.002

The recovery shows that the gaps have moved in a direction opposite to that of the stress applied, and the maximum recovery has occurred in the sand-cast annealed specimen and the mini-

* Morley. Strength of Materials.

mum in the centrifugal specimens, leaving the final change in gap due to squeezing somewhat less than the original measurements. It is also of some importance to note that the recovery in gap after this standing period is quite a substantial percentage of the change due to squeezing, being 10 per cent. in the case of the centrifugal and nearly 16 per cent. in the sand-cast annealed specimen.

The same test-rings were subjected to gradual stressing by a load applied across a diameter at right-angles to the gap in the direction of opening the ring (*i.e.*, opposite to the squeezing to gap closure already applied) and described in the specifications as "tensile" loading. The load was removed at uniform intervals and the permanent change in gap measured. These results are plotted in the diagrams. Fig. 2 shows the relation between total gap increment and load, Fig. 3 the relation between permanent set expressed in inches increment of free gap and increment of stress.

TABLE V.—*Influence of Extended Time.*

Specimen.	Stress. Tons per sq. in.	Gap after stressing. Ins.	Gap after standing overnight. Ins.	Change. Ins.	Gap after standing 48 hrs. Ins.	Change. Ins.
(*a*) No. 6 ..	14.06	0.604	0.596	— 0.008	0.592	— 0.012
(*b*) No. 6 ..	14.06	0.586	0.580	— 0.006	0.580	— 0.006
(*c*) No. 6 ..	14.25	0.522	0.520	— 0.002	0.518	— 0.004

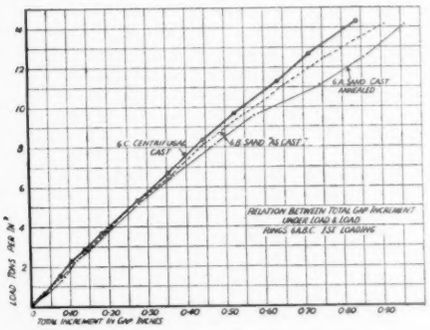
LOAD TONS PER IN²
TOTAL INCREMENT IN GAP INCHES
6.C. CENTRIFUGAL CAST
6.B. SAND "AS CAST"
6.A. SAND CAST ANNEALED
RELATION BETWEEN TOTAL GAP INCREMENT UNDER LOAD & LOAD
RINGS 6.A.B.C. 1ST LOADING

FIG. 2.

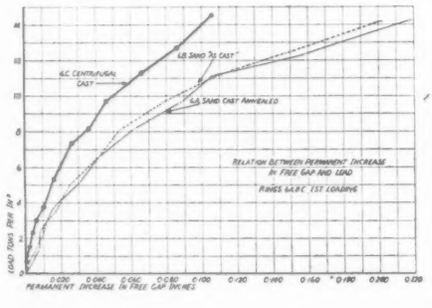
6.B SAND "AS CAST"
6.C CENTRIFUGAL CAST
6.A SAND CAST ANNEALED
RELATION BETWEEN PERMANENT INCREASE IN FREE GAP AND LOAD
RINGS 6.A.B.C. 1ST LOADING
LOAD TONS PER IN²
PERMANENT INCREASE IN FREE GAP INCHES

FIG. 3.

gap closure already applied) and described in the specifications as "tensile" loading. The load was removed at uniform intervals and the permanent change in gap measured. These results are plotted in the diagrams. Fig. 2 shows the relation between total gap increment and load, Fig. 3 the relation between permanent set expressed in inches increment of free gap and increment of stress.

It is clearly demonstrated by these results that the total gap extension increases with increasing load, and is the greatest for a given stress value in the annealed specimen and the least in the centrifugal specimen. All the specimens show measurable permanent set at the minimum stress values and in whatever manner expressed, increases in magnitude with increase in stress. The magnitude of permanent set at all stress values is least in the centrifugally-cast specimen and is approximately one-third the value of the permanent set in the sand-cast specimens. On the whole, the permanent set is slightly greater in the annealed than in the "as-cast" specimen, particularly at the higher stresses. The maximum stress value adopted in these experiments was chosen quite arbitrarily at 14 tons per sq. in. The final gap measurements obtained immediately after straining were checked after allowing to stand overnight and found to have decreased slightly. The specimens were allowed to stand a further 48 hrs. and a still further slight decrease was noted. The actual measurements are summarised in Table V.

The outstanding feature is that after tensile stressing, gap opening, the change in gap, is in the direction opposite to the applied stress and is negative, exactly reversing the behaviour of the same rings after squeezing to gap closure. The annealed specimens show the greatest movement and the amount of change in this specimen is equal to over 1 per cent. permanent set (expressed as a percentage of total gap extension), and about 0.4 per cent. in the centrifugally-cast specimens. The relationship between the magnitudes of this gap hysteresis in the various materials is the same as in the previous test of closing the gaps.

In neither case is there any clear connection between the magnitude of these phenomena and the magnitude of the internal stress as indicated by the free movement of the gaps on cutting. The test-rings were finally broken right out by the application of load along the diameter at right angles to the gap. The results expressed as tensile strength are recorded in Table II.

The experiment was repeated using fresh test-rings No. 5 from the same samples of material. The determinations of the EN values on these test-rings are given in Table VI.

The gap measurements marked * and † were made after squeezing the rings once for the "Diam. cut" measurement and after the second squeeze for the EN determination. Again, as a result of squeezing, the gap has changed, although the magnitude of the change is less than in the previous specimen from the same samples. It will be remembered, however, that the previous specimens were subjected to three separate squeezing operations.

The internal stress as indicated by the gap movement differs from the three previous specimens. The annealed sand-cast specimen shows a substantial gap movement of a negative character and the "as cast" specimen shows a 50 per cent. greater gap movement than in the previous specimens. The centrifugally-cast specimen shows exactly the same amount of gap movement. The EN values are also slightly lower than in the previous specimens.

The test-rings were subjected to gradual tensile loading in exactly the same manner as the previous rings except that the loading was taken up to a higher value of 17.85 tons (approximately 18 tons per sq. in.). The tests were made commencing at 10.30 a.m. on August 12, 1932. The permanent increments in gap with increments of stress are illustrated diagrammatically in Fig. 4, and whilst differing slightly in magnitude the implications are the same as those derived from the previous experiment. The final gap measurements obtained were checked after the specimens had been allowed to stand for intervals of 24 and 72 hrs. respectively, with the results shown in Table VII.

TABLE VII.—*Influence of Time on Gap.*

Specimen.	Gap after stress, Aug. 12, 10.30. Ins.	Gap after standing 24 hrs. Ins.	Change. Ins.	Gap after standing 72 hrs. Ins.	Change.
(*a*) No. 5	0.616	0.608	— 0.008	0.608	Nil
(*b*) No. 5	0.608	0.600	— 0.008	0.600	Nil
(*c*) No. 5	0.570	0.564	— 0.006	0.564	Nil

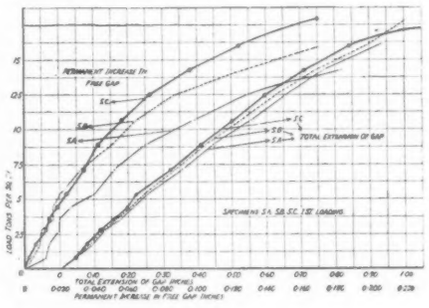
PERMANENT INCREASE IN FREE GAP
TOTAL EXTENSION OF GAP
SPECIMENS 5.A. 5.B. 5.C. 1ST LOADING
LOAD TONS PER IN²
TOTAL EXTENSION OF GAP INCHES
PERMANENT INCREASE IN FREE GAP INCHES

FIG. 4.

These results are slightly different in magnitude from those obtained with the previous specimens, but the change is in the same direction, viz., opposite to the direction of applied stress. After standing for a period of 72 hrs. no further change over that recorded after 24 hrs.' standing is obtained.

(To be concluded.)

TABLE VI.

Specimen.	Gap as cut. Ins.	Gap released. Ins.	Increment of gap. Ins.	Dia. uncut. Ins.	Dia. cut. Ins.	*b*. Ins.
(*a*) No. 5 ..	0.414	0.406	— 0.008	4.53	4.40	0.250
(*b*) No. 5 ..	0.414	0.402	— 0.006	4.53	4.40	0.252
(*c*) No. 5 ..	0.414	0.422	+ 0.008	4.53	4.40	0.252

Specimen.	*t*. Ins.	Gap. Ins. *	Gap. Ins. †	Lbs.	EN. Lbs. per sq. in. × 10^6.
(*a*) No. 5 ..	0.1425	0.382	0.374	11.15	17.05
(*b*) No. 5 ..	0.1425	0.382	0.374	11.50	17.59
(*c*) No. 5 ..	0.142	0.406	0.40	11.60	16.69

Catalogue Received

Goggles. A leaflet received from Messrs. S. Pulzer & Son, Limited, of 45, Hatton Garden, London, E.C.1, deals with welders' and fitters' goggles, and, as usual with this progressive firm, something definitely novel and health-maintaining is put forward. Thus we have noted how the dangerous rays have been excluded; how ventilation has been provided for; how the danger from splintering has been obviated through the use of laminated lenses; how irritation has been eliminated by providing a sweat-proof material, and, whilst doing all this, lightness has been considered, as no one wishes to carry excessive weight on the nose bridge. Yet with all these things there remained one problem, and that was cleanliness, but now in the latest model illustrated, the whole goggle readily "comes to bits" for proper cleansing and is just as easily "mended." We congratulate this firm and in our felicitations include all others which consistently work with such intelligence for safeguarding eyes against industrial hazards.

Factors in the Economic Conduct of Vitreous Enamelling*

By J. H. Coupe, of Belling & Company

Vitreous enamelling is developing very rapidly in this country, and costing is of great importance. In reading this Paper it is not proposed to give monetary figures, as these can be very misleading in circumstances that differ very widely. Instead, the subject will be confined to matters which concern production costs, and a description given of some methods which have been found from experience to be helpful in reducing these costs.

Costing methods, of course, vary in different enamelling works, and depend upon many factors such as location and lay-out of factory, disposition of plant, type of labour available, design, quality of castings, and of work required, etc. Methods of muffle firing must also be taken into consideration. In dealing with this subject, the author speaks from experience of the conditions applicable in the enamelling departments of Belling & Company's Works at Enfield. It is proposed to deal exclusively with the vitreous enamelling of cast iron.

Location of Factory

Dealing firstly with the location of factory, this should be situated near a labour centre, and transport facilities are of great importance. A factory badly situated in these respects would be very much handicapped on account of high transport charges and wages, also by the difficulty of obtaining the best class of labour.

Lay-out of Factory

The lay-out of factory and plant is of vital importance. This should be arranged on a continuous-flow system, and back tracking should be avoided wherever possible. These facts are no doubt familiar, but it is felt that they are worthy of mention owing to their influence on basic costs. There should be no difficulty in laying out an entirely new enamelling plant on ideal lines, but everybody appreciates the difficulties which arise when making extensions to existing plant, especially if increase in business has exceeded previous calculations.

Castings

As the quality of the castings have a profound influence on enamelling costs, the following points are important:—Mixture of a satisfactory composition must be used, laxity in this respect can make enamelling difficult and expensive. For instance, impurities such as an excess of sulphur, and hard castings due to bad mixing, are definite drawbacks. Pitting and non-adhesion of enamel may be traced to these causes.

The mixture and charges used at our Enfield works, which have given satisfactory results, are as follow:—

Pig-iron Analysis. — T.C. 3.46; C.C. 0.3, Gr 3.16, Si 3.0, Mn 0.4, S 0.02 and P 1.38 per cent.

Charges for a 2-ton Cupola.—

	Cwts.	Qrs.	Lbs.
Coke	0	3	20
Pig-iron	7	2	0
Heavy scrap	1	2	0
Light scrap	6	0	0
Limestone	0	1	8

Design of castings should be carefully considered. Unevenness in thickness such as heavy bosses, etc., must be avoided whenever possible. All edges should be rounded. Careful gating is essential in order to avoid wash on the face of the mould. Other faults which are likely to produce unsatisfactory castings for enamelling are non-venting and badly-lined hand ladles, pouring metal too hot and too quickly. Castings should not be removed from the moulds before they have cooled sufficiently, otherwise distortion is likely to occur.

Additional costs are incurred by the same type of castings varying in weight. As an example, take castings of the same design weighing approximately 14 lbs. These may vary from 2 to 3 lbs. The effect of this, of course, must vary the fusing time factor. Unless the load is withdrawn from the furnace when the lighter castings are fused, they will be over-fired by the time the heavier castings are ready, or, alternatively, the light castings must be withdrawn, and the heavier ones put back for further fusing. This process may be carried on two or even three times with the same load, definitely slowing down production. The foundry can naturally help to keep down enamelling costs by close attention to these details.

Skimped fettling leaving sharp edges, etc., is another cause of unnecessary expense in the enamelling shop. If greater attention be paid to inspecting and grading castings before entering the enamelling shop, by someone with a knowledge of the requirements of the enameller, a substantial saving could be effected.

Annealing

The cost of annealing castings varies with the type of furnace used. It is obviously more economical both in fuel consumption and maintenance costs to do this process in a furnace specially designed.

Aim for as large a satisfactory load as possible, and in this direction there is great scope for the reduction of costs by designing perrets of double and triple decks, hanging racks, etc. Co-operation with the furnace builder and the perret manufacturer is essential if the highest efficiency is to be obtained.

It is thought that the annealing of castings is not universal, but it is debatable whether the omission of this succeeds in lowering costs. The number of rejects experienced must be higher, and in the long run more than swallow up the extra cost involved in annealing; at any rate, this has been personal experience. Increased output can also be obtained from the sandblast room when castings have been annealed.

Sandblasting

The introduction of high-pressure sandblast apparatus, eay, 60 to 70 lbs. pressure, has made it possible to use successfully liquid enamel on cast iron, and plays a most important part in the enamelling operations which follow on.

The following remarks will deal with the type of plant used in the authors' works. There are three in use, two being served by a 100-h.p. electric motor, belt-driven, and the third by a 50-h.p., also belt-driven.

The cost of power in this case is a definite factor. Other methods of obtaining power, such as gas, oil, etc., are worthy of consideration, and all are conditional upon the district.

Sandblast costs do, of course, vary with the type of work to be done. It has not been found possible in the present case to arrive at any costing figure by calculation of weights only, especially when castings differ in weight from, say, 1 cwt. to a quarter of a pound. The best way is to judge each type of casting on its own merits and cost accordingly.

The output from one room is as follows:—

A. Castings weighing ½ cwt. 12 per hr.
B. " " ¼ " 20 " "
C. " " 14 lbs. 40 " "
D. " " 10 to 5 lbs. 50 to 80 per hr.
E. Smalls, say, weighing ¼ lb. 300 per hr.

These figures are taken generally from a range of 500 different types of castings. This is a very wide difference, and castings of the same weight but different in shape or size show varying production figures.

Abrasives

A mixture of flint grit and angular steel shot has been found satisfactory and economical. When flint grit is used entirely it has a greater searching effect upon the skin of castings, and enamel appears to "flow" more readily than on a surface blasted with steel angular shot only. The latter seems to have more of a battering than a searching effect, but has the advantage of durability. Other items of costs to be taken into consideration are maintenance, operation, replacements, protective clothing, etc.

Various types of compressor drives are in use, but in the present case, where belt drives are used, it has been found that considerable saving in cost has been made by the adoption of an endless belt of a rubber preparation for the main driving belt from a 100-h.p. motor to the compressor; its size 12 in. wide by ⅜ in. thick. Belts of the balata type joined with belt fasteners were found to be very costly in upkeep. The excess of heat generated by the high speed caused repeated breakages and laminations, and these breakdowns affected the whole of the enamelling output.

The present method of providing air to the helmet of the sand-blast operator leaves very much to be desired, and manufacturers are urged to carry out further research with a view to improvement in this respect. Air taken from the high-pressure compressor in the usual manner becomes very hot and objectionable after the machine has been running a few hours. The drop in output caused by this is considerable. The author has conducted a number of experiments to obviate this trouble, and found that a separate compressor of the low-pressure type, located in a cool spot, considerably improved working conditions and increased production.

These remarks on sand-blastings concern the room type of machine only. For the rotary system, the sequence of operations requires two men, who sand-blast the faces of castings only, after which they are transferred to cabinet type machines for further sand-blasting of edges. Apart from extra handling, the maintenance costs are probably higher than when using the room type machine.

Inspection and Filling of Castings

All castings should be inspected, well dusted and filled if necessary. The amount of filling entirely depends upon the quality of the castings. In the author's case very little filling is necessary.

Frits.—The making of satisfactory frits has the greatest bearing on enamelling costs. In view of the highly technical research involved in the production of frits, the author is quite content at the moment to buy in the open market. Probably, if the research resources of frit manufacturers could be pooled, it would be of enormous benefit to the enamelling industry as a whole, and still further increase the sales of vitreous enamelled products. Economical reduction in the cost of frit will enable the enamellers to compete more favourably with manufacturers using other finishes.

Milling.—Controlled specifications are desirable in any operation of enamelling, but are imperative in the mill rooms, and cleanliness is essential. The care and regularity in milling enamel can make success or failure of the remaining operations. Therefore, there should be definite methods and accuracy for weighing mill load, milling time, fineness test, inspection of mills and pebbles, cleaning of mills, and method of handling enamel from the mill. The consistency of wet enamel should be carefully checked before passing on to sprayer, either by meter or by weighing.

* A paper read before The Institute of Vitreous Enamellers in London, Mr. B. B. Kent presiding.

A few factors likely to cause trouble in future operations are as follow:—(1) Black specks or chips from using dark flint pebbles in mills; (2) iron particles from steel-door frames; (3) storage tanks not dustproof; and (4) colour contamination from grinding a white enamel in a mill that has been used for a coloured enamel. Referring to this, one or two mills should be kept specially for white, and if possible (where capital permits) a separate mill for each colour used, saving time and labour in cleansing. Time spent in cleaning out mills is wasted and cannot be regained. Other savings can be made by the use of magnetic separators and mechanical sieve vibrators, etc.

Spraying

In spraying there are many important things to keep in mind, such as the proper condition of guns, clean air-lines, correct air-pressure, and frequent agitation of enamel. Poor spray guns create bad finish; correct atomisation is essential to prevent uneven or lumpy application of enamel. The use of iron air-lines in the spraying system is one of the causes of black specks in the finished article, owing to the action of water condensing out of the compressed air, and rusting the inside of the pipes. This rust is carried into the spray guns and on to the article being sprayed.

This trouble can be eliminated by the installation of non-rusting air-lines. Air filters should be fitted in the pipe-lines in order to prevent dirt and oil from the compressor getting into the spray pistols. Air pressure, too low for the gun, will not atomise the stream of enamel sufficiently, and tends to produce a rough surface.

Too high a pressure—although claims may be put forward that work can be covered more speedily—is also highly detrimental when a really good finish is required, the reason for this being that the rapid flow of air does not allow sufficient time for the particles to settle correctly on the surface of the article. Further, too great a pressure is, in personal opinion, conducive to waste.

Production costs in spraying depend upon the size, shape and class of work to be done; also:—(1) Single-sided work; (2) double-sided work; (3) one coat and mottle (4) coloured work requiring two coats or more; and (5) shading or multi-coloured work. Each piece should be individually considered and costed accordingly.

The following are a few examples of the output figures from the spraying booths:—Assorted cooker castings sprayed and mottled, single and double sided; 4 cwts. per hr., from three booths, two men spraying and one mottling. These castings vary in shape and weight, the smallest weighing under ¼ lb., the largest 28 lbs.

For fire fronts, one man spraying one coat one side on a straight run of one particular design, weighing 9 lbs. each and measuring 14 in. by 13½ in. by 6½ in. deep, produces an output of 3½ cwts. per hr. Compare with this another fire front, 14 in. by 15 in. by 1 in. deep, weighing 5 lbs., sprayed under the same conditions, the output is 2 cwts. Production in the last two examples again varies with shade of enamel used, delicate pastel shades requiring more time and skill in application than, say, dark drown or black.

Drying

Wide and various are the methods of drying, but it is obvious the most economical way is by utilising the waste heat from the furnace. Here, again, there is a great need for research. Heat extractors at present in use leave much to be desired, as they only succeed in reclaiming a small percentage of the total waste heat. All the types inspected require an auxiliary burner. The heat losses are also very high in the baffled and staggered-flue types.

The installation of a continuous drying conveyor should be more economical where a large output is demanded, but are not extensively used in this country. The aim should be to dry at the greatest possible speed that the enamel will allow. Great attention here is important, as work dried too quickly or too slowly will cause rejects, particularly in one-coat work.

Saving is effected in time and cost when the position of the drying chambers is conveniently situated between the spray booths and furnaces, allowing work to pass through in a straight line. Where no automatic conveyor is in operation, it shows a saving if rack trolleys are used direct from the sprayer through the drying chamber, and up to the side of the loading fork. This eliminates unnecessary handling.

Fusing

To obtain the most economical production of high-quality finish on cast iron, the type of furnace is all-important. The author has experimented with four different types, namely, radiant type, under-fired, over-fired and Dressler type. He is not in favour of the over-fired type, but the other three types mentioned have their separate advantages.

The Dressler furnace has been found to be most suitable for continuous heavy loads of cast iron. When a large weight of cold cast iron in addition to the cold-perret equipment is placed in the furnace, the temperature falls considerably.

The time taken to regain the peak temperature affects production figures and costs. The furnace referred to, size 9 ft. by 4 ft. by 3 ft. 6 in. high, regains this temperature in 15 mins., with the following load:—Perret equipment, 4½ cwts.; and casting load, 2½ cwts. The average oil consumption is 5 galls. per hr., including lighting up.

The class of enamel used by the author is satisfactorily fused in the time stated. Should the furnace regain the peak temperature too quickly, castings of uneven thicknesses, due to lugs, bosses, webs, etc., will not heat up evenly—blistering and over-burning of the enamel will result. On the other hand, should it take, say, 30 mins. for the furnace to regain the peak temperature, the enamel applied to the castings does not suffer in any way, but the production would be halved.

It should be understood that no comparison is being made between the latest-type under-fired furnace and the Dressler. This would be distinctly unfair, as the under-fired one in use at the moment was installed nine years ago.

Considerable waste of fuel and loss of production does take place where the capacity of the furnace is not used to the fullest extent. It is far more economical to utilise extra labour, if necessary, to ensure continuity of loading and reloading. Full advantage should be taken of suitably-designed perrets of double and triple decks, hanging racks, etc.

Temperature control of furnaces is imperative. All modern enamelling shops are equipped with recorders, which should be closely controlled. Thermostatic control would simplify fusing, but personal experience of this applied to oil burners has not proved very satisfactory. This method of control is used successfully in electric furnaces.

The electric furnace is, in personal opinion, the ideal for enamelling. Its pure heat, absence of gases, speed and ease in control are far in advance of any other heating medium. The construction of the modern electric furnace, with its absence of flues and efficient insulation, reduces heat losses to a bare minimum. When sufficient reduction in the price of electric current for industrial purposes is made, this type will become almost universal.

Dusting of Cast Iron, including Majolica

Attempts are continually being made to produce a majolica effect with a liquid-spraying enamel. So far these efforts have not yet met with commercial success. In the preparation of castings for this dusting process there are two methods of cleansing, namely, washing and wire-brushing or sandblasting. The latter has been proved to be more economical in the long run, owing to the increased adhesion of the enamel. The author's works do a large quantity of majolica work, the castings varying from 1 lb. to 1¼ cwts. The average twenty-four hour output from a Radiant-type furnace, size 5 ft. by 3 ft., employing three men on each of three shifts is 1 ton 5 cwts. With certain types of small castings it is found possible to double these figures by duplicating the shift gangs, all using the same furnace with its normal consumption.

The author has recently designed and perfected a dusting booth, primarily with the object of protecting the duster from heat and improving his working conditions generally. Two of these are now installed in his enamelling shop. The output figures mentioned prior to the installation of these booths were considerably less. The improvement of working conditions is always a safe investment.

Wage Incentives

It is obvious that wage incentives, correctly applied in strict fairness between the employer and employee, are of great benefit to both, the result being increased output and efficiency, on the one hand, on the other hand, better wages, with greater personal interest in the quality of the work. The average workman is not really interested in systems, the opportunity to increase earnings being his chief concern.

In costing, where raw piecework prices are applicable as a basis, this system is undoubtedly the best. The management is able to carry this method out both in sandblasting and majolica dusting. A definite price is fixed for each casting, and the total work done constitutes the wages paid. Moreover, the management is considering applying this scheme to the fusers in order to encourage them to work the furnaces to their full capacity.

Dealing with all other operations, a group-bonus scheme has been found satisfactory. Men are paid various hourly rates according to grade. A definite price is fixed for every article to be enamelled, and when finished these parts are passed through an inspection department, quantities checked, and compared weekly with the total wages paid. Any surplus is then proportionately distributed according to the rate of pay. This takes care of all labour costs, which can be checked at any time, also shows up any excess of labour and the general rate of production.

Material Costs.—All materials used, such as abrasives, frits, clays, oxides, etc., should be carefully balanced against production.

General Overhead Charges

These naturally depend to a large extent on local conditions. Amongst other items, the following overhead charges should be included when costing:—(1) Interest on capital; (2) rates and taxes; (3) fuel, power, water and lighting; (4) maintenance; (5) depreciation of plant, etc.; (6) waste; (7) office and supervising; (8) research; (9) advertising; (10) packing and carriage charges; and (11) insurance. These should be worked out and allowed for on a percentage basis.

Conclusion

Costing may vary in detail, but the general principles remain the same. Systems that are too elaborate are often very costly, and it should be the aim of all manufacturers to strike the happy medium. Do not carry too heavy stocks, and avoid excess of labour, especially of the non-production type.

DISCUSSION

Output from Rotary Tables

MR. J. T. GRAY said that the largest rotary table used in this country within his knowledge, having a diameter of 9 ft. 3 in., could certainly be operated by one man, and did not need two. One man could keep the rotary table going efficiently and secure the maximum output, which Mr. Gray had found to be, when using steel grit, 5 to 6 cwts. per hr. on general light-stove castings. Figures should be compiled not on

the basis of output per machine, but on the basis of man-hours. For a rotary table, the figure would be, say, 5 cwts. per man per hour.

The question of fettling had been put forward, and Mr. Gray said that he had met with much difficulty in various works with regard to fettling, especially on long, sharp edges. In many works, fettlers considered that, if they ran the edge of the casting over the grinding wheel, they had fettled it, but this very often resulted in putting two angles of 45 deg. on the casting instead of one of 90 deg., and two angles close together very often caused pinching and jumping-off of the enamel, whereas, if the corner were correctly fettled by rounding these, trouble would be eliminated.

Maintenance Costs

MR. COUPE commented that the figures given by Mr. Gray were very interesting, but he would like some costs of maintenace for the rotary table, which he believed were very high.

MR. GRAY said he was getting the figures together, and would have accurate information available in connection with a Paper which would be submitted later.

MR. W. MCCALLA said that over a considerable period he had had the opportunity to visit one of the largest works in the Southern area, where rotary sand-blasting machines were used, and on each occasion when he had visited the works there had been two men working each machine.

Drying With Waste Gases

MR. A. B. KENT contended that in castings which had come straight from the foundry and had been fettled, the fettled parts hardly needed sand blasting equally all over. Annealed castings needed blasting. In his experience, when sand blast of the room or cabinet type only was worked, the men, knowing they controlled the whole output of the plant, periodically went slow, and had petty breakdowns. One could not see what a man was doing with his time when working in a room, but one could control the output of a rotary table. As soon as a rotary table was installed, he found that the men working the rooms and cabinets tried to keep up with the output of the table. It was not his experience that all types of driers needed an auxiliary burner, as suggested in the Paper. At his works, they had one of the staggered-flue types, and when the furnace was working at "cast-iron" temperature (720 to 740 deg. C.), a temperature of 140 deg. Fah. could be attained in the drier, the air having been circulated by taking out the air by means of a fan from one end of the dryer and blowing it into the other. There was no rust spotting.

Mr. Kent, referring again to the maintenance of a rotary table, said further that it could be run for 24 hrs. per day during the week and could be shut down on Friday night; a team of engineers could renew any necessary parts, which were cast in the foundry, and the table could be running again by Saturday at 3 o'clock. In that way very little expense was incurred.

MR. COUPE mentioned a cabinet-type machine which had been running night and day for the past six months without any breakdown at all.

Sand-Blasting and Annealing

MR. W. S. GRAINGER recalled an investigation he had made about twelve months ago concerning sand-blasting installations, and said he had obtained some very interesting opinions, mostly from the maintenance point of view, from many of his friends who were using or had used rotary tables. None of those opinions was complimentary. Then he had carried out some tests and had proved conclusively that the cabinet type was the best type on the whole. But he gathered that the newest and the most satisfactory installation was one in which the two types were combined, *i.e.*, having a rotary table in a cabinet, and that would probably solve many of the difficulties concerning maintenance.

His experience confirmed that of Mr. A. B. Kent that a longer time was required to sand-blast annealed castings—not exactly to get them clean, but to get rid of that last little bit of oxide which seemed to get into the pores.

Mr. Grainger called attention to the author's statement with regard to drying; that saving was effected in time and cost when the drying chambers were conveniently situated between the spray booths and furnaces, allowing work to pass through in a straight line, and that where no automatic conveyor was in operation it showed a saving if rack trolleys were used direct from the sprayer through the drying chamber and up to the side of the loading fork. He asked how one avoided rust spotting when loading up the rack.

He also asked whether it was usual to include interest on capital as an item in the costs, or whether the interest on capital was just the profit at the end of the year (if any).

Object of Annealing

MR. COUPE disagreed with the remarks made concerning annealing. The object of annealing was to soften castings and to eliminate excluded gases. Obviously a softened casting was more easily attacked by any abrasive, such being the case, production was increased.

With regard to drying, the sprayer sprayed the work, passed it on to a table behind him; it was carried on a trolley into the drying room by a boy; when the work was dry the trolley was pushed through alongside the loading fork. In that way one handling was saved. He believed it was the usual procedure to include interest on capital as an item when arriving at production costs.

MR. GRAINGER said he would like the views of an accountant on the matter, because he did not think it was usual to include interest on capital as a charge, but rather to put it against profits at the end of the year. Dealing with sand blasting, he asked whether, if one used flint with the shot, it was necessary to cover oneself against silicosis.

Flint and Silicosis

MR. COUPE said that when using a mixture of shot and flint one was still up against the difficulty with regard to the silicosis regulations, which still applied. But the use of a mixture of steel shot and flint did to some extent overcome the silicosis trouble, and that was the main reason for using it in his works. His own belief was that the flint grit was the best material for sand blasting.

MR. H. FRY, having regard to the difficulties arising due to silicosis regulations when sand was used for blasting, asked whether it was impossible to get a good result when using steel shot only. It seemed obvious that one should avoid the use of sand if that were possible.

Flint and Final Finish

MR. COUPE expressed the view that the results obtained with flint grit were much better than when using steel shot only. He added that two very large firms in this country, who did quite a quantity of enamelling, had changed over some little time ago to steel shot only, but found that the acid-resisting properties of the enamel disappeared; therefore, they had been compelled to revert to the use of flint and grit.

What Rotary Table Upkeep Involves

MR. J. H. GRAY, discussing the maintenance of rotary tables, mentioned his recent experience in starting up and putting into production a rotary table which was subsequently working 22 hrs. per day. It was found necessary to have an engineer attend to the rotary table at meal times and on Saturday afternoons, but it was subsequently found that most of the trouble should have been avoided. It was due to some extent to the faulty setting of the machine and the engineer in charge being unfamiliar with the equipment. He confirmed the remarks of Mr. J. T. Gray concerning output because he personally had been working a rotary table quite recently and obtained an output of 6 cwts. per hr. over a period of two weeks on light stove castings.

Staffing Rotary Tables

MR. FLETCHER, having had a long experience of rotary tables, said that maintenance costs were definitely higher as compared to cabinet machines. With a two-nozzle rotary and two single-nozzle cabinets working side by side, it was found that the cabinets cost very little in maintenance, against a costly weekly overhaul and replacement of parts on the rotary machine. At first, two cabinets were used, with a man on each, and piece-work prices were fixed, giving a price for edges, etc., and a price for surfaces that would eventually be done on a rotary machine. The two-nozzle rotary was then started, with one operator, and all work off this machine was paid for at half cabinet rates, so that half the labour cost was saved.

Before long, more output was required, and he was satisfied that he could secure it by putting a second man on the rotary and so making a squad of four men, who would continue to pool their earnings. The firm still paid the same for the blasted castings, full rates for cabinet production and half rates for rotary production. No extra flint was used, maintenance costs were not increased; and yet the wages paid were sufficient, so that each of the four men earned 25 per cent. more than each of the three men had previously earned.

This extra output, being all obtained from the rotary table, meant that two men on this machine earned 50 per cent. more than two men on cabinets. This at half rates gave an output from the rotary nozzles three times greater than the output from two cabinet nozzles. This would easily offset the heavier maintenance cost, and proved that two men were essentially on a rotary table to get maximum output. He used flint grit exclusively. As a trial, steel only was used for a week; it was found that the output of castings dropped considerably; the men worked on the same piece rates, and earned far less wages during the week steel was used.

MR. J. H. GRAY asked Mr. Fletcher whether the fourth man he started in the sandblast department was actually working on the rotary table or whether he was a kind of general help to the other three operators, *i.e.*, on the rotary table and the two cabinets, and whether it was in this way that he obtained the higher output.

MR. FLETCHER replied that the fourth man could not help on the cabinets because there was a man already at work on each cabinet nozzle there, therefore he was definitely at work on the rotary.

Annealing an Aid to Sand-blasting

MR. J. T. GRAY said that while it was true that the object of annealing was to soften the metal being so treated, there is no reason for annealing castings for enamelling because if annealing were necessary the casting would obtain all the softening it required during fusing. The sole object of so-called annealing of cast iron prior to enamelling was to drive out occluded gases which would otherwise give trouble during fusing. This so-called annealing also had a beneficial effect inasmuch as it loosened the scale on the face of the casting and also any burnt-on sand.

Effect of Grit Cleaning

MR. KENNETH HILL suggested that if the author incorporated an abrasive cleaner in his plant he would do away with all his difficulties as to the surface obtained when using steel grit in contradistinction to that obtained when using flint grit. He believed that graphitic carbon was taken with the steel shot during its passage through the plant, so that when it impinged upon the casting again it gave rise to black spots. If the abrasive were cleaned mechanically and automatically each time it

XUM

passed round the chamber, the graphite would be eliminated.

With regard to the statement that breakdowns were more frequent on rotary tables than on any other sort of sand blast machine, he suggested that was due to the fact that there were more exposed mechanical parts on the rotary table.

There was difference of opinion as to whether the output from the sand blast was increased or decreased as the result of annealing the castings before sand blasting. He suggested that the reason why some people contended that the speed was lower was that they were not using the correct type of steel abrasive for an annealed casting; after all, the annealed casting was soft, and consequently the skin had not to be so much rapped off as cut off. One needed to use a much finer grade of material for an annealed casting than for a casting received straight from the foundry; the latter must be hit hard by a heavier grade of material.

Presumably the apparatus comprising a rotary table in a cabinet, mentioned by Mr. Grainger, was a new type of sand blast which cut out all air. This, however, was at the moment in rather an experimental stage.

Time and Quality

MR. E. O. HEWISON, referring to the author's figures of output from his sand blasting rooms, drew particular attention to item B, relating to ¼ cwt. castings, which were dealt with at the rate of 20 per hour, and he asked whether a hot-plate of that weight could be sand blasted on both sides, an area of 4 ft. per side, in three minutes. It seemed to him that that was a very short time to allow for satisfactory sand blasting, which had to get into the pores of the metal.

MR. G. REDMAN said that item B did not cover hot-plates; it covered particularly the large castings used for the dusting process.

Rent and Other Charges

MR. J. PEDDER said that in a manufacturing plant each machine represented capital outlay, and should make its contribution to meeting the cost of the capital. The basis usually adopted was the yield of a similar sum invested in gilt-edged securities, plus a percentage to cover the risk of running an enamelling business. The interest on capital should be calculated on each unit of plant.

Another factor to be borne in mind was that, even though the premises were owned by the Company using them, a rent charge should be made for the use of the shops; in that case the rates and taxes could be allocated directly to each shop. Fuel, power, water, lighting, and maintenance and depreciation of plant could also be calculated directly on the plant involved.

A SPEAKER, dealing with Mr. Fletcher's assertion that the sandblasting process was slowed down when steel shot was used instead of flint as the abrasive, asked whether the financial loss involved by the slowing down of the process was greater than the cost of the insurance on the men which would have to be paid when flint was used, in accordance with the Home Office regulations concerning silicosis.

Cost and Production Speed

Mr. Fletcher replied that it was more costly to use steel grit by reason of the slowing down process. The running costs remained, on an hourly basis and output per hour was down, also the piece-work prices would have to be increased considerably, for the men had not earned their time-work money when using the steel grit. While on steel, possibly some adjustment of nozzles, etc., might have improved matters. However his Company wished to get all it could from the plant installed, for power and maintenance costs were items to be considered before a slight saving on abrasives and if the men could earn good money on flint, then flint would be used. When investigating the steel shot, he had personally stood by in order to make sure that the men were working properly and he felt satisfied that it was advantageous to use flint.

MR. J. T. GRAY mentioned a case in which the results obtained were directly opposite those mentioned by Mr. Fletcher. A large company producing work similar to that of Mr. Fletcher's company changed over from the use of flint grit to steel shot, and after a week's work with the steel shot the men agreed to a reduction in the piece-work prices. No doubt much depended on the type of apparatus being used.

MR. COUPE again pleaded for some actual figures of costs, instead of mere speculation as to what might be the results. Mr. Gray had hinted that he would be able to give actual cost figures, taking into account breakdowns, maintenance, and so on.

MR. J. T. GRAY said that that would be dealt with in the Paper he was to present at a later date.

Belting Economies

MR. H. L. HARTLEY, commenting on Mr. Coupe's experience that considerable saving in cost was effected by adopting an endless belt of a rubber composition for compressor driving, asked if he had tried "V" slot belt drives. Some compressor manufacturers were pushing such drives because the space occupied by the plant was reduced by reason of the short centres, and the flexibility rendered this form of drive more beneficial than direct coupling; also, savings were effected in initial cost. Mr. Hartley said he knew of cases in which such drives had run day and night for four years without any replacements.

MR. COUPE replied that he had not tried the "V" slot belt drives.

MR. H. WHITAKER asked if Mr. Coupe had tried using a pressure lower than 60 or 70 lbs. for sandblasting, because his own company had adopted a lower pressure and had found it satisfactory?

MR. COUPE replied that when the pistons began to wear the pressure was thereby lowered, and the results obtained were not so good. In his experience the pressure should not be less than 65 lbs.

Dusting Majolica Ware

MR. J. H. GRAY asked whether the majolica enamel used by Mr. Coupe was lead-bearing, and, if so, what method he used for dusting before the newly-designed dusting booth mentioned in his Paper was introduced?

MR. COUPE replied that the majolica enamel he was using contained a percentage of lead. Prior to the adoption of the machines recently introduced, the equipment consisted of a fan fitted into a hood over the dusting table. This arrangement did not carry away the dust from the operator and allowed a certain amount to float about in the workshop. The new booth designed on similar lines to the ordinary spraying booth overcomes these drawbacks, thereby improving working conditions and speeding up output.

The CHAIRMAN, in proposing a vote of thanks to Mr. Coupe for his Paper, said that it was only to be expected that the discussion should have centred around sandblasting, because it accounted for at least 50 per cent. of the cost of cast iron enamelling.

The vote of thanks to Mr. Coupe was carried with acclamation, and the meeting closed.

COPPER PRODUCTION in Canada in August totalled 32,703,462 lbs., as compared with 29,484,128 lbs. in July and 28,243,639 lbs. in August, 1933. Nickel production in Canada in August amounted to 14,272,129 lbs., as compared with 10,660,423 lbs. in July and 10,216,700 lbs. in August, 1933. During the first eight months of 1934 copper output totalled 239,329,393 lbs., as against 186,326,250 lbs. during the corresponding period of 1933, whilst nickel output advanced during the same period from 42,232,024 lbs. to 88,266,238 lbs.

Costing for Vitreous Enamelling

(*Concluded from page* 403.)

MR. TODD agreed with Mr. Mileson, and said they had previously exchanged views on the subject. An accountant, especially in a small works, should advisedly be either the technician or the works manager in order to take advantage of their technical knowledge. But when he raised the point in his Paper, he had in mind that there were various types of accountants, just as there were works managers of varying capabilities; and some of them seemed to form narrow views in regard to what they termed non-productive labour. The very word "inspection" implied non-productive work to such accountants, yet it was just as necessary as such work as toolmaking and patternmaking; and where they could directly pin such costs on to productive labour charges, an enlightened accountant would agree that it was desirable. It was better not to hide the charge, but to bring it out for proper allocation. There had been cases where an entirely non-technical man in his investigations sought to lay down hard-and-fast rules which were not based on sound deductions from technical and practical application. In this respect Mr. Mileson and himself were in agreement. He considered that the latter had raised a very interesting point in his opening remarks, and one which could be reviewed to good purpose. Some plants were being worked to destruction. On the one hand they would hear of a muffle which had lasted four years, and in another case only two years; but the comparison depended upon the service to which these muffles had been subjected. Had they been working, as in some instances was the case, for 24 hours a day for six and a-half days a week, or had they been closed down on Friday night and then heated up rapidly on Monday morning? All these were definite factors which must be taken into account when they were considering the life of plant and working it to the most economic advantage.

Vote of Thanks

MR. W. H. WHITAKER proposed a vote of thanks to Mr. Todd.

MR. W. J. SPITTLE seconded, and said the organisation and mechanisation of plant and its effect on cost accountancy was a matter which could be profitably discussed, which Mr. Todd acknowledged. Naturally, investigations would have to be made in the first instance, and the initial charges should generally be allocated or expressed as overheads.

Import of Unwrought Nickel

The Treasury, on the recommendation of the Import Duties Advisory Committee, have made the Import Duties (Exemptions) (No. 18) Order, 1934, adding to the Free List, as from December 17, nickel, unwrought, in rondels, but not including alloys of nickel. The Committee consider that nickel imported in the form of rondels should be exempted from duty equally with the other forms of unwrought nickel which are already on the Free List.

Book Review

The "Rapid" Total Weight Calculator. Published by Gall & Inglis, 12, Newington Road, Edinburgh, 9. Price 1s. 6d.

This little book covers weight calculations from 2 at 4 ozs. up to 1,000 at 112 lbs., going up steadily first by half-pounds and later by 5 lbs. We have taken several tests, and are satisfied that much time can be saved, and we recommend the book to those constantly handling this type of calculation.

Some Light Alloys Containing Nickel

The merits of certain light aluminium alloys containing nickel are now well appreciated and their use has become established practice for the production of castings for specific duties by the pressure die casting, gravity die casting and sand-casting processes.

One of the prominent manufacturers of such castings is the Birmingham Aluminium Casting (1903) Company, Limited, whose products include the well-known "Y" and "R.R." alloys and certain other alloys having special features.

Their Birmasil Special, a patented aluminium-silicon-nickel alloy, has a nickel content of 2.5 to 3.5 per cent. Its high tensile strength, good

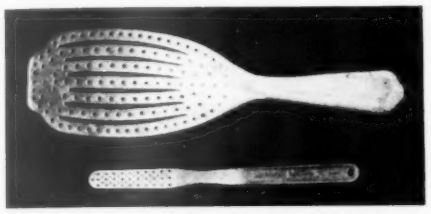

FIG. 1.—BRUSH BACKS OF BIRMAL PRESSURE DIE CASTING ALLOY.

elongation, resistance to corrosion, low thermal expansion and good heat conductivity make it eminently suitable for such castings as cylinder heads, brake drums having cast-iron or steel liners, and crankcases for abnormally heavy duties.

Another special product is the Birmal pressure die casting alloy. This very stable alloy contains 1.75 to 2.5 per cent. of nickel associated with copper and silicon, and has an ultimate tensile strength of 10 to 12 tons per sq. in., an elongation of 0.5 to 1.5 per cent. on 2 in. and a fatigue range of ±4.25 tons per sq. in.

It has been very successfully used for a wide variety of purposes, including brake shoes, clutch covers and plates for automobiles, crankcases and gearboxes for motor cycles, carburettor bodies for marine purposes, vacuum cleaners, automatic slot

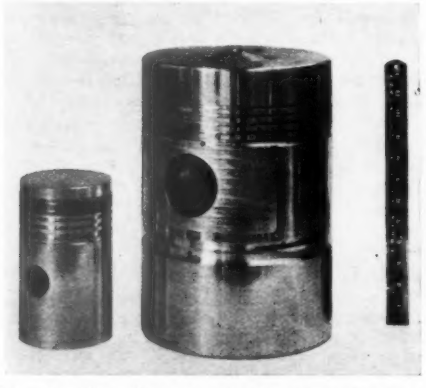

FIG. 2.—THE PISTON SHOWN ON THE LEFT IS FITTED WITH A RING CARRIER OF AUSTENITIC NICKEL CAST IRON. THE HEAVY DIESEL PISTON ON THE RIGHT IS OF "Y" ALLOY.

machines, automatic telephone apparatus, radio equipment, camera parts, tennis racket presses, optical instruments, electric meters and brush backs.

Its suitability for the production of very complicated and accurately-finished castings is illustrated by the photograph of a hairbrush back as used by the Kleen-e-ze Brush Company. The small holes and grooves for attaching the bristles are produced direct by the casting process in the die.

"Y" alloy is used by the Birmingham Aluminium Casting Company for many different purposes. One of our illustrations shows a heavy Diesel piston of heat-treated "Y" alloy, and this material is also used for such applications as motor-car pistons and Diesel-engine cylinder heads. After repeated failures with other alloys, "Y" alloy has been chosen also for the casings of percussion tools and is standing up to this work remarkably well.

The smaller piston illustrated, made of a high-silicon aluminium alloy, makes use of nickel in a different way. It incorporates a ring carrier of austenitic cast iron containing 13 per cent. of nickel in addition to other special elements. This material has a coefficient of expansion equal to that of the aluminium alloy, thus obviating the usual troubles consequent upon the differential expansions often experienced when aluminium alloys are used for pistons. This piston is covered by British Patents 38367 and 402945.

Yet another special aluminium alloy, containing about 1½ per cent. of nickel in addition to other constituents, is in constant use for casting pressure cookers.

Development of Glass Enamels

EXTENSIVE USE IN FOOD AND OTHER INDUSTRIAL EQUIPMENT

One of Scotland's newest industries was referred to by Dr. E. E. Geisinger when addressing a joint meeting of the Glasgow Sections of the Society of Chemical Industry and the Institute of Chemistry, together with the Scottish Branch of the Institute of British Foundrymen, in the Royal Technical College, Glasgow, on a recent occasion.

DR. GEISINGER was speaking on "Developments in Glass Enamels and Their Industrial Application," and in outlining the varied uses found for enamelled metalware, he said that glass-enamelled steel equipment could be found in nearly all industries where storage or processing receptacles were required. It was without doubt the equipment material which had the fewest limits, and this could be said in due respect to all ferrous or non-ferrous alloys, as well as stoneware or glass products. When the size of the unit was around 1,000 gallons or over, the price of the equipment per unit gallon was a recommendation, whilst for smaller units the quality and freedom of any contamination to the product being processed was much in the favour of enamelled metalware. Glass-enamelled steel could be heated and cooled severely without damage, and its smooth surface allowed of easy and thorough cleaning, whilst it could be sterilised with an assurance that the surface was not harbouring spores which resist sterilisation.

Glass-enamelled metal was ideal for the storage of liquids, and for neutral liquids like beer or milk the size of the tank was only limited by the size of the enamelling furnace and storage facilities. Present-day glass enamels contained no ingredients of a poisonous nature like lead, antimony or arsenic. Enamelled metalware also resisted corrosion, and one of the most permanent protections for steel was a coating of fused silicate glass.

In America dwellings and store fronts were being enamelled, and Dr. Geisinger predicted that the silicate coating of large and worth-while things was just beginning. He also suggested that all corrodible metal in mines could be enamelled, and said that it had been suggested that ship's propellers should be enamelled to cut down friction and stop corrosion and erosion.

Earlier in his address Dr. Geisinger had dealt in some detail with the physical and chemical compositions of these enamels, and had explained the modern processing of silicate-coated metalware, ranging from the smallest article in jewellery to large steel containers weighing over 8 tons.

The application of the glass to metal was, he said, carried out according to the particular ware being processed, but, in every case, the aim to apply as thin a coat of glass enamel as possible, since it had been found that a heavy base of metal covered with a thin skin of glass gave many years of service.

The types of furnaces used for firing enamelled ware were also described by the lecturer, who said that there had been erected at Leven, Fife, an enamelling furnace which was as big as any in the world, and which, in spite of its size, had reached a surprising degree of efficiency.

Cast Red Brass

Mr. C. M. Seager, junr., the author of the last American Exchange Paper, writes as a reply to the discussion:—

It was, indeed, a pleasure to prepare the A.F.A. Exchange Paper for presentation at the annual meeting of the Institute of British Foundrymen. Unforeseen circumstances regrettably precluded my personal presentation of the Paper. I wish to extend my thanks to Mr. Delport for his very able presentation of my Paper as well as his apt characterisation of its salient points. His presentation and characterisation doubtless stimulated much of the broad constructive discussion of the different problems covered by the Paper.

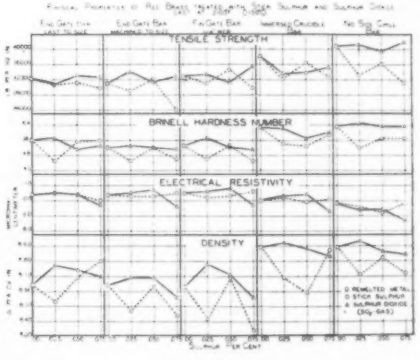

FIG. A.—INFLUENCE OF SULPHUR ON THE PHYSICAL PROPERTIES OF RED BRASS.

Both Mr. Gardner, Research Associate of the Non-Ferrous Ingot Metal Institute, and myself were pleased to learn that the Institute of British Foundrymen is engaged in a similar investigation in an attempt to reduce the number of specifications of the commercial non-ferrous metals. Such investigations will do much to stimulate greater interest in non-ferrous metal specifications and their controlled simplification. It is believed that such control is but one of the many problems in whose solution the trade on both sides of the Atlantic may join hands to the lasting benefit of the public generally, as well as of all foundrymen.

We note with interest the discussion initiated by Mr. Rowe regarding the effect on the physical properties of additions of stick sulphur to the molten metal. Since the presentation of the Exchange Paper, we have completed a second series of melts in which the molten metal was treated for various time intervals with gaseous sulphur dioxide. Data obtained from these tests are shown on the accompanying chart (Fig. A). A comparison of the data of these tests with those obtained in the previous study using stick sulphur indicates that the differences in the effects on the physical properties of the alloy are small. In fact, it may be stated that sulphur added as sulphur dioxide gas has a less injurious effect on the physical properties of the alloy than the same amount of sulphur added in stick form.

Rapid Determination of Oxide in Molten Steel*

By A. B. Kinzel, J. J. Egan, and R. J. Price†

The *rôle* played by the oxide content of a steel bath during various stages of refining is receiving increased attention from the steelmaker. Increased knowledge of the chemical reactions involved in steelmaking relates the qualities of the final product to the oxide content of the bath and further relates this oxide content to the slag composition. Thus, it is common practice to control the oxide content of the steel by predetermining the slag analysis. However, no method for directly determining the oxide content of the bath has been available for the steelmaker to use during the course of the heat. All previous analytical methods have required too much time for such application, and it is generally agreed that a method for determining iron oxide in molten steels rapidly would be of great value. This problem was accordingly studied at the Union Carbide & Carbon Research Laboratories. Various methods are being investigated, and that here described has been brought to a sufficient state of perfection to warrant its consideration for use in the open-hearth furnace plant. It involves the conversion of iron or other oxides to alumina, together with an improved rapid determination of the alumina content. Essentially it is an improvement of the Kichline[2] and Herty[1] procedure.

The use of aluminium for killing spoon samples for analysis requires a special procedure, and difficulties have been experienced in some works. However, a sufficient number of users have found the method satisfactory, so that it may be safely assumed that, with proper technique, the oxygen content of the steel bath may be quantitatively fixed in the form of alumina in the sample. It is believed that pouring over aluminium wire with careful blocking of the slag is the most suitable means for avoiding difficulties.

Some question has been raised as to the quantitative formation of alumina if silica or silicon is present in the molten steel. Our experience indicates that the alumina is formed quantitatively and that no appreciable error is to be expected from this source. It might be further mentioned that the presence of highly stable carbides, such as tungsten carbide, will interfere with the analytical procedure. However, there is generally no occasion for running a rapid analysis when such stable carbides are present.

Sampling

The sample having been obtained in small ingot form, drillings are taken in the usual way, and subjected to the improved analytical procedure. In essence, this consists of dissolving the steel in nitric acid containing ammonium persulphate, adding a small quantity of specially-prepared carbon, concentrating the solid matter in a hand centrifuge, decanting and filtering the concentrated residue, igniting in an oxygen atmosphere and weighing. The entire analytical operation takes 7 to 10 mins., depending upon the skill of the analyst. A description of the procedure, together with the discussion, follows.

Analytical Procedure

Five g. of fine steel drillings are added to 250 ml. of 30 per cent. nitric acid warmed to 30 deg. C. and contained in an 800-ml. covered beaker. It is essential that the drillings be comparatively fine, as large pieces will unduly increase solution time. The steel is immediately followed by 15 g. of ammonium persulphate. On completion of solution, 15 ml. of hydrochloric acid (specific gravity 1.19) and 0.05 gr. of ashless lamp black held in suspension in 20 ml. of water are added, and the whole vigorously stirred. With properly-prepared drillings, the solution time of the 5-gr. sample will be approximately 2 mins.

Nitric acid is used instead of hydrochloric, as recommended by Kichline,[2] as it dissolves the steel much more rapidly and without attacking the alumina. Care should be taken not to heat the acid above 30 deg. C. Acid heated to the boiling point will dissolve some of the alumina. Ammonium persulphate is added to the acid in order to increase carbon solution. It is particularly important in high-carbon samples, where large carbon flakes interfere with the speed of the following operations. The ashless lamp black is added in order to facilitate the subsequent centrifuging. The lamp black in suspension should be previously filtered by centrifuging commercial lamp black several times with intermediate decantation.

Sample.	C. Per cent.	Oxygen. Per cent.	
		Standard Method.	Union Carbide Method.
1	0.20	0.029	0.028
2	0.91	0.050	0.050
		0.048	0.048
3	0.02	0.192	0.190

The solution which now contains alumina, carbon from the steel, and added carbon as solid matter is then centrifuged. This operation is carried out in a hand centrifuge at about 1,800 r.p.m. for 1 min. The two-bulb type, each bulb containing 175 ml., is preferable. The supernatant liquid is decanted, leaving the precipitate in approximately 10 ml. of liquid. This entire operation should take approximately 1½ mins., very materially reducing the time necessary for the subsequent filtering operation. This should be carried out using two No. 42 superimposed Whatman papers (6 cm.) with gentle suction; a small amount of ashless paper pulp is used in the apex, and the papers are supported on a small platinum cone. The precipitate is washed with warm 5 per cent. hydrochloric acid and transferred to a flat-bottomed platinum dish. Due to the special preparations that have been made in the previous step of the procedure, the filtering time should not exceed 1 min.

The contents of the platinum dish are ignited in a small furnace at approximately 900 deg. C. The muffle should be flushed with pure oxygen before the dish is put in, and the stream of oxygen should be maintained during the ignition in such a fashion that no direct gas current impinges on the inside of the dish. This is essential to avoid loss of the very fine particles. Following the ignition, the platinum dish is cooled in water. This entire operation should take approximately 2 mins. The ignited alumina is transferred to the balance pan and weighed. It has been found that each weighing may be carried out in ½ min. or less. The oxygen is calculated directly from the alumina.

Concordance of Results

It will be seen from the above description that the total time for the operation will be less than 10 mins. In order to check the accuracy of the results obtainable by this method, samples have been analysed by the standard alumina method, as previously described by Cunningham and Price.[3] Typical results on samples of low and high carbon and variable oxygen steels follow.

This method is thus shown to be sufficiently accurate and sufficiently rapid, so that it should be of direct use in determining oxygen content of the steel during the course of the heat.

* Extracted from "Metals and Alloys."

† The authors are on the research staff of Union Carbide and Carbon Research Laboratories, Long Island City, N.Y.

1 Herty, Freeman and Lightner, "Bureau of Mines Reports of Investigations," No. 3166, April, 1932.

2 J. Kichline, "Industrial and Engineering Chemistry," Vol 7, 1915, page 806.

3 Cunningham and Price, "Industrial and Engineering Chemistry, Analytical Edition," Vol. 5, 1933, page 27.

Japan and Manchukuo

In a recent conversation with Mr. J. E. Hurst, the Vice-President of the Institute of British Foundrymen, on the subject of training in foreign languages, he said more or less seriously that he thought that he would like his daughter to learn Japanese and Russian. We were reminded of this when studying an extremely important brochure—Report of Mission to the Far East issued by the Federation of British Industries. It is stated that Japan is very serious in its endeavour to industrialise. Moreover, it has been successful to a large extent, although up to now the percentage of world trade transacted is not a high figure. The determination of Japan to pursue this policy is based on ever-increasing population and the present ability to compete in the world's markets because of the depreciation of the yen and the low (from the European but high from the Oriental) standard of living of its industrial workers. An interesting interjectory remark of an apposite character is made by the delegates in this connection. The fact that Japan is mechanising its industries as fast as it can may defeat its end, because of so many labour-saving devices!

Manchukuo comes into the picture because of the following considerations. The standard of living is so low that Japanese cannot compete with the local labour. Japanese have invested a mint of money in the railway system and elsewhere. The Japanese are poor colonists. But, say the Japanese, if by modernising a country as big as central Europe with a teeming population, and creating therein an adequate buying capacity, a really important market for Japanese manufactured goods will be created. It is obvious that the delegation was favourably impressed with their reception, and stress that by the cementation of Anglo-Japanese friendship, British participation in this market could be effected to the mutual advantage of the parties. Committees in Tokio and London are being formed for this special purpose. The Far Eastern problem is difficult, yet fascinating. By careful and sympathetic understanding it can be the greatest factor in international peace, but misunderstanding and mishandling reveals a prospect of an economic war, less spectacular, but nevertheless as dreadful in its consequences as military and naval warfare.

Sweden's First Aluminium Works

In co-operation with the great Norwegian aluminium interests, a Swedish company was formed in January for the manufacture of aluminium in Sweden. The extremely modern factory of the company, which is situated at Avesta, within easy reach of fairly abundant and cheap hydro-electric power, has recently been started up with some ceremony for the reception of a new member into the Swedish industrial community.

In a speech at the opening, the main features of the enterprise were reviewed. These are, in brief, that the plant has a capacity of about 1,800 tons per annum, which approximately corresponds to the aluminium consumption in Sweden. The plant consists of 46 large smelting furnaces, and two special furnaces for casting certain aluminium alloys.

The factory building has a length of about 450 ft. and is constructed entirely of steel and concrete, with two large storage towers for the raw material. For the present the semi-manufactured raw material is obtained from the Norwegian works, the Swedish works producing the finished aluminium and alloys. The rolling, including other manufacturing processes, on the other hand, is done, as far as Sweden is concerned, at various metal works in the country.

This Week's News in Brief

Trade Talk

To ASSIST industry and commerce the Belgian Government has reduced railway freight rates by 10 per cent.

A GERMAN DELEGATION arrived in Dublin last week to discuss the possibility of a trade treaty between Germany and the Irish Free State.

MESSRS. PNEULEC, LIMITED, have acquired a sole licence from the American Foundry Equipment Company to manufacture the Wheelabrator in this country.

KARRIER MOTORS, LIMITED, are holding an extraordinary meeting to-morrow to consider winding up the company voluntarily and the appointment of a liquidator.

ABOUT 95 PER CENT. of the work at present in hand at the Darlington works of the Whessoe Foundry & Engineering Company, Limited, is for shipment abroad.

A JAMES WATT ENGINE has been presented by the Metropolitan Water Board to Loughborough College. It was constructed by Messrs. James Watt & Company, Soho, in 1850.

A NEW CONTINUOUS MILL for rolling high-grade steel sheets for the motor-car industry is to be erected in the New Year at the Normanby Park Steelworks, Scunthorpe, of Messrs. John Lysaght & Company, Limited.

COCHRANES (MIDDLESBROUGH) FOUNDRY, LIMITED, manufacturers of cast iron and centrifugally-made iron pipes, have opened an office in Manchester at 16, Deansgate, Manchester, 3, and have appointed Mr. H. S. Davie to be sales representative in Manchester and the North-West.

WHILST REPAIRING A ROOF at Messrs. David Brown & Sons (Huddersfield), Limited, Huddersfield, Mr. Walter Jones slipped and fell a distance of 40 ft., receiving a compound fracture of the right leg, a fracture of the left leg and head injuries. In falling he struck Mr. Arthur Haigh, a fitter, who suffered from scalp wounds.

SPLASHES OF MOLTEN METAL are thought to have been the cause of a fire at the works of Messrs. E. Hargreaves & Company, ironfounders, of Water Lane, Halifax. The outbreak occurred in a wooden and brick building used as the blower house, but, fortunately, the fire brigade was able to prevent the flames from spreading to the foundry.

THE NEWS is confirmed that the Blaenavon blast furnaces have been acquired for demolition by Messrs. Thos. W. Ward, Limited, Sheffield. Recently, one of the furnaces was reconditioned and hopes were entertained locally that pig-iron production would be renewed. However, as announced last week, the directors have decided not to maintain the blast furnaces. The plant consists of three blast furnaces and ten hot-blast "Cowper" stoves, with turbo blowers, "Halberg" gas-cleaning plant and necessary equipment. Demolition of the Blaenavon blast furnaces will remove another link from the chain of ironworks that formerly stood at the head of the Monmouth and Glamorgan valleys.

IN THE COURSE of a review of progress during 1934, Messrs. David Brown & Sons (Huddersfield), Limited, state that the general improvement in trade is reflected by an increased demand for gears and gear units of every type, and as the world's largest gearmakers, they are able to report a satisfactory influx of orders, not only from gear users at home, but also from various countries overseas. Their "Radicon" reducers, introduced in May of last year, have already been supplied for transmitting, in the aggregate, tens of thousands of horsepower. The present position is one which inspires great optimism for the future; the firm has in hand a number of important contracts, including some exceptionally large winder-gears for South African gold mines, also roll-driving and other gears for the new Corby steelworks.

Metro-Vick Activities in 1934

(*Concluded from page* 400.)

control gear, a new liquid controller, known as the LC.1500, has been developed, suitable for use with motors up to 1,500 h.p. The past twelve months has seen a further big increase in the use of electrically-driven apparatus for underground service in collieries, particularly in connection with machine-mining.

THE UNITED PATTERNMAKERS' ASSOCIATION reports 1,295 members unemployed, an increase of 90 compared with the previous month. Of these 351 are on transitional benefit. Mr. James Barr, Greenock, has been re-elected Scottish member of the national executive. Nominations for the position of assistant and financial secretary are to take place this month. Mr. W. J. McLardy, the present official, is eligible for re-election. The executive has recommended new auditing arrangements as the result of a national conference of secretaries.

Company Meeting

Cleveland Bridge & Engineering Company, Limited

Presiding at the annual meeting of the Cleveland Bridge & Engineering Company, Limited, held at Darlington recently, MR. J. R. DIXON (chairman and managing director) said that although a general improvement in trade had been reported, it had not yet been reflected in the bridge-building and structural industry, and the continued shortage of inquiries and consequent cutting of prices had resulted in very few orders being booked. There were, however, several schemes in view for the class of work for which their organisation was best suited, both at home and abroad, and they were keeping in touch with these with a view to securing the orders. The company retained its strong financial position and still had a fair amount of work in hand. Referring to the progress of the work on the Lower Zambesi Bridge, Mr. Dixon said that the last span of the bridge was erected on October 11, exactly four years from the signing of the order and well in advance of the time laid down in the contract. Exceptionally good progress was made this season, as more than half of the total steelwork in the bridge was erected in seven months.

Contracts Open

Argentina, March 15.—Twelve electric overhead travelling cranes, for the Argentine State Railways Administration. The Department of Overseas Trade. (Reference A.Y. 12,827.)

Belfast, January 5.—The Belfast Harbour Commissioners invite tenders for a 30-ton electrically-operated gantry crane. The superintendent of cranes, etc., Harbour Office, Belfast.

Cairo, February 26.—Ministry of Public Works, Cairo, invites tenders for complete road metal quarrying plant. The Chief Inspecting Engineer to the Egyptian Government, 41, Tothill Street, London, S.W.1.

London, E.C., January 3.—Supply and erection of 17 weighbridges, for the Metropolitan Water Board. The Chief Engineer, the offices of the Board (Room 155), 173, Rosebery Avenue, E.C.1.

Company Reports

Millom & Askam Hematite Iron Company, Limited.—Preference dividend withheld.

Atlas Steel Foundry & Engineering Company, Limited.—Profit, £5,461; sinking fund for redemption of debentures (two years), £3,000; depreciation, £1,500; debit balance brought in, £8,497; debit carried forward, £7,535.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Cometal, Limited.—Capital £100. Manufacturers of and dealers in iron and steel, alloys and sheet metal. Directors: H. D. Cooper and F. W. W. Wootton.

The Oldest Grey-Iron Casting.—Mr. C. E. Williams informs us that in his letter, published in our last issue, the words "which had a cast wire," which we questioned, were due to a typist's error. The passage in Mr. Straker's book was "the interior is of cast iron," and Mr. Williams intended to paraphrase this as "which had a cast-iron bore."

Personal

MR. J. C. MAHINDRA, general sales manager of the Tata Iron & Steel Company, Limited, is on holiday in England.

MR. A. T. S. ZEALLEY, works manager of the Billingham works of Imperial Chemical Industries, Limited, has been appointed managing director in succession to Dr. R. E. Slade, who has been transferred to London as head of the I.C.I. research department. Mr. Zealley went to Billingham in 1921, when the works were in course of development.

MR. R. P. SLOAN, chairman and managing director of the North-Eastern Electric Supply Company, Limited, Newcastle-upon-Tyne, who is resigning from the position as chairman, has been presented with a gift subscribed for by 2,000 employees of the firm. It is understood Mr. Sloan will retain his directorship of the company, and will continue as managing director for a short period. He is being succeeded as chairman by Mr. H. A. Couves, general manager and director.

Wills

SMEETH, T. J. WATSON, of Messrs. T. S. Smeeth, iron, steel and metal merchants, Bradford £14,706

Obituary

MR. STANLEY WARD, a director of Messrs. William Ward & Son (Sheffield), Limited, saw and tool manufacturers, died recently, aged 43.

WE REGRET TO ANNOUNCE that Mr. W. H. Proctor, managing director of the Wycliffe Foundry Company, Limited, and Follsain Metals, Limited, Lutterworth, died on Tuesday, December 18, after a very short illness.

MR. WILLIAM BROWN, engine works manager of Messrs. Palmers Shipbuilding & Iron Company, Limited, has died at his residence at Gosforth, Newcastle. Mr. Brown went to Jarrow in 1911. He was a member of the North-East Coast Institution of Engineers and Shipbuilders.

EX-BAILIE MACRAE, who is managing director of the North British Steel Foundry Company, Limited, has intimated that for health reasons he proposes to retire from Bathgate Town Council, on which he has served for 14 years. He was within a year of being appointed Provost of the town.

MR. GEORGE L. A. GRAFENHAIN, a well-known figure in Sheffield steel-trade circles, died on December 13, at the age of 69. Mr. Grafenhain was of German birth, but had been a naturalised Englishman for many years. He joined the firm of Seebohm & Dieckstahl, Limited (now Arthur Balfour & Company, Limited), at the age of 19, and subsequently became Continental representative and also a director. He left the firm during the second year of the war, and some time later he joined Darwins, Limited, as Continental sales manager. He remained with that firm until about two years ago. Since his retirement he had acted as a special representative for Messrs. Edgar Allen & Company, Limited, in connection with the Continental business.

Forthcoming Events

Institute of British Foundrymen

JANUARY 5.

Lancashire Branch:—"The International Foundry Conference in the United States," Paper by T. Makemson at the Engineers' Club, Albert Square, Manchester, at 4 p.m.

Wales and Monmouth Branch:—"Bronze Castings," Paper by E. J. L. Howard at the Technical College, Newport, at 6.30 p.m.

JANUARY 8.

Burnley Section:—"The Making of High-Duty Irons," Paper by G. Hall at the Municipal College, Ormerod Road, Burnley, at 7.15 p.m.

JANUARY 9.

Preston Section:—"The Moulder and his Craft," Paper by C. A. Otto at the Technical College, Corporation Street, Preston, at 7.30 p.m.

London Branch:—"Some General Remarks on Mechanised Foundries and the Making of Motor Cylinders," Paper by G. W. Brown, M.I.Mech.E., at the Charing Cross Hotel (First Floor), London, W.C.2, at 8 p.m.

Raw Material Markets

During the past week business in iron and steel materials has, of course, been almost entirely at a standstill. Consuming works in Scotland are due to close down almost immediately for a week, and stock-taking is being generally entered upon, so that a full resumption of activity is not expected before the middle of January. The blast furnaces, which have, of course, been running during the stoppage, have accumulated a certain amount of iron, but these stocks are not likely to remain a burden for very long, judging by the well-filled condition of the furnaces' order-books.

Pig-Iron

MIDDLESBROUGH.—The makers of Cleveland foundry iron are very well placed for orders over the first quarter of the New Year. In view of the pressing demand for ferro-manganese, another blast furnace, prepared at short notice, was restarted in the Middlesbrough area on Sunday. This will be the second furnace in this district producing ferro-manganese. It increases to 27 the total number of furnaces at work in the area, of which three are producing Cleveland iron, two ferro-manganese, ten hematite and twelve basic iron. Home prices of Cleveland pig-iron remain unaltered. The minimum quotation for No. 3 Cleveland G.M.B. grade delivered Middlesbrough is 67s. 6d. Export prices are still uncontrolled.

The East Coast hematite makers are in a strong position, home consumers having booked heavily over the coming quarter, in addition to which the export demand has lately shown some signs of revival. Prices are unchanged.

LANCASHIRE.—There has been practically a complete cessation of pig-iron deliveries to foundry and engineering establishments this week, and a resumption is not expected till Monday. In the absence of business, quotations are nominally unchanged, with offers of Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron for delivery to Lancashire users quoted on the basis of 74s. per ton, Northamptonshire at 72s. 6d., Derbyshire forge at 69s., Scottish foundry at about 82s. 6d., East Coast hematite iron at from 75s. to 76s. per ton, according to quality, and West Coast at around 78s. 6d.

MIDLANDS.—Some of the ironfoundries in this area reopen to-day, but in many cases a resumption is being delayed until Monday. It is considered that there is little possibility of a change in prices one way or the other. The Association minimum rates delivered Birmingham and Black Country stations are 67s. 6d. per ton for No. 3 Northants, and 71s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, less a graduated rebate to large consumers.

SCOTLAND.—Ironworks in this area are closing down towards the end of this week, and conditions in the pig-iron market have hence been very quiet. There is no change in the price of No. 3 Scottish foundry at 70s. f.o.t. furnaces, with 2s. 6d. per ton extra for No. 1. The light-castings works will probably resume on January 7. Meantime, they have been curtailing deliveries of pig-iron in view of stock-taking. For No. 3 Cleveland iron they are still being quoted 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow and district. Other English foundry iron is quoted at 1s. 3d. per ton less

Coke

The foundry-coke market will open the New Year on a strong note, as most of the ovens are well booked over the first quarter. Quotations for delivery in the Birmingham area nominally remain as follow:—Best Durham fuel, 34s. to 40s.; Welsh, 35s. to 45s.; Scottish coke, 40s. to 41s. per ton.

Steel

Both production and consumption of steel have been affected by the holiday, while new business has, of course, been almost at a standstill. The manufacturers have, however, sufficient business in hand to ensure a satisfactory resumption, although the expansion of business will, to a certain extent, be delayed by the usual stock-taking operations. The export outlook is rather more hopeful now, although there are many difficulties still to be overcome in this connection.

Scrap

Up to the holiday there was quite a good demand for scrap-iron. In the Cleveland area, foundry cast-iron was quoted at 52s. 6d. per ton and good machinery metal at 53s. 6d. to 55s. The market price of light iron advanced to 42s. 6d., on a stronger demand. There has been no alteration in the scrap-iron situation in the Midlands, quotations remaining unchanged. In South Wales there was a fair demand for heavy cast-iron scrap at 50s. to 52s. 6d., but good machinery scrap was quiet at 55s. In Scotland, machinery cast-iron scrap in pieces suitable for foundry cupolas, is in good demand at 57s. 6d., with ordinary cast-iron to the same specification around 52s. 6d.

Metals

Copper.—Industrial buyers have shown little interest in the market lately, owing to the holiday and stocktaking periods, and dealing has largely been of a speculative character. Industrial consumers generally are inclined to await the outcome of the forthcoming producers' conference in New York before committing themselves ahead.

Unofficial estimates relating to the copper industry during November have now been issued. They reveal that producers' stocks fell by about 18,500 short tons during the month, to 474,600 short tons. Deliveries in this country during November were 26,497 short tons, against 29,629 tons in October.

Tin.—Activity in the tin market has, of course, been very restricted recently. The November tin export figures have now been issued by the International Tin Committee. November exports amounted to 8,235 tons. Rumours have been circulating of increased dissatisfaction among certain producers with the restriction scheme.

Spelter. — The value of foreign spelter on the London market has lately touched the lowest level since July, 1932. The fall was largely due to forebodings about the fate of the International Zinc Cartel, to the future of which no clue is yet forthcoming.

Lead.—Business has been slack on the London market, and it is realised that consumers are not likely to show much buying interest until the middle of next month.

[For latest quotations and daily fluctuations see price-list pages.]

Portable Air Compressors

Foundries achieve such enormous dimensions nowadays that even such machines as portable compressors may find a use during experimental lay-outs or for work about the yards. A really efficient model, Type 80, has been involved by Messrs. Armstrong, Whitworth (Engineers), Limited, of Thames House, Westminster, S.W.1, and it is described in publication No. 614. The booklet is logically set out, well illustrated, and printed in clear type.

FALCONBRIDGE NICKEL MINES, LIMITED, are now treating a grade of ore containing about 2¼ per cent. of nickel and 1 per cent. of copper, from which 15 tons of nickel and between 6 and 7 tons of copper are being turned out daily in matte form. The new five-compartment shaft, which is to be sunk to 1,000 ft., is now down to 350 ft., whilst the reduction plant is being operated at its daily capacity of 750 tons. Ore reserves at the end of 1933 were estimated at 2,817,884 tons, and the available plant, at its present rate of production, is expected to produce, this year, a total of about 10,000,000 lbs. of nickel matte for shipment to the refinery at Kristiansand, Norway.

A Study of Ground-Coat Enamels

A study of the strength and elasticity of some ground-coat enamels has been completed by the United States Bureau of Standards, which reports that the following conclusions, applicable to the range of compositions studied, were reached:—

(1) Substitution of sodium and boric oxides, one or the other, and of feldspar and flint, one for the other, caused no important change in Young's modulus of elasticity, although a definite trend was observed.

(2) The changes in modulus of rupture caused by such substitutions were relatively small and are outweighed by other considerations.

(3) The changes in modulus of rupture with composition, though small, were systematic. Substituting boric oxide for sodium oxide increased the strength, and increasing the flint to about 30 per cent., with a corresponding reduction in feldspar below 30 per cent., caused an appreciable decrease in strength.

(4) The scatter in the results on modulus of rupture varied systematically with the composition, and varied in some cases directly and in others inversely with the strength.

(5) The computed extensibility of the enamels varied within a range of 0.14 to 0.19 per cent. in direct proportion to the modulus of rupture.

(6) The frequency distributions of the strengths of different specimens of the respective enamels were approximately symmetrical.

(7) The stress-strain curves for these enamels were linear up to the stress causing failure, and their slopes were not influenced by the rate of loading.

(8) The time factor had a marked effect upon the apparent strengths, failure occurring at substantially lower stresses with increased duration of the stress periods.

Catalogue Received

Heat and Corrosion Resistant Steels. Messrs. Firth-Vickers Stainless, Limited, Staybrite Works, Sheffield, have produced a really excellent catalogue which covers steels specially resistant to rust, acid, and high-temperatures—this, in fact, is its title—but we candidly dislike the appearance of the cover, on the following grounds: a metal paper of insufficient thickness has been used which has caused creasing and the partial disappearance of the pigment. Insufficient red has been used, which is also a contributory factor. The idea was a good one, but it has not been a success. The section on castings makes really interesting reading, and the progress registered is of an amazing character. Users of stainless steels will welcome the detailed information which is given on spinning, pressing, welding, polishing, and machining. This information is definitely reliable. It is impossible to obtain it in text books, whilst it is very "scattered" in the technical Press.

We were very interested in the shovels illustrated on page 39. Editorial staffs may be pernickety, but not one could reconcile the picture with the inscription, though all were agreed as to the import. But our interest is not in precision of description, but as to whether such shovels have been or are worth trying out in the foundry. Moulding sand is not corrosive, but very erosive and stainless material might be worth while. If not there should be some other special steels capable of being put to this use, as in spite of mechanisation there are still a few thousand shovels being used within the industry. We strongly recommend the various foundry executives to procure for study and filing a copy of this exceedingly useful catalogue.

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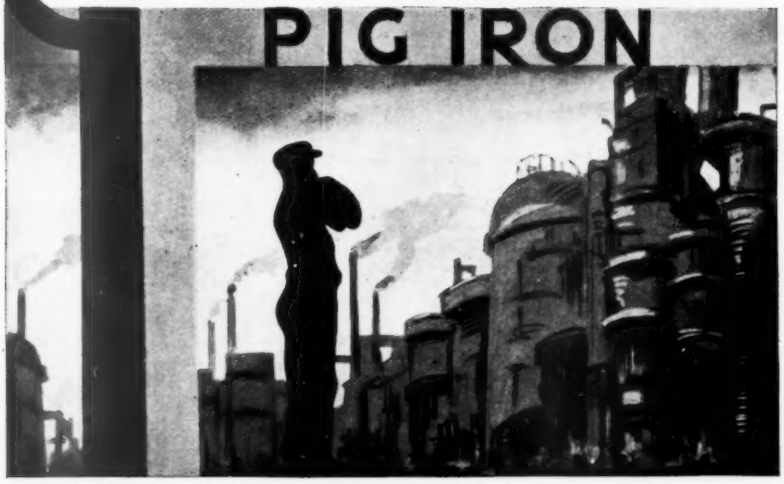
COLVILLES PIG IRON



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RAW MATERIALS—PRICE LIST

(Monday, December 24, 1934)

COPPER

	£	s.	d.
Standard cash	28	7	6
Three months	28	16	3
Electrolytic	31	10	0
Tough	30	5	0
Best selected	30	15	0
Sheets	58	0	0
India	41	10	0
Wire bars	31	15	0
Ingot bars	31	15	0
H.C. wire rods	34	10	0
Off. av. cash, November	27	5	5 3/4
Do., 3 mths., November	27	12	0 9/44
Do., Sttlmnt., November	27	5	5 5/11
Do., Electro, November	30	10	4 7/22
Do., B.S., November	30	3	7 1/3
Do., wire bars, November	30	16	4 4/11
Solid drawn tubes			9½d.
Brazed tubes			9⅞d.
Wire			6d.

BRASS

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	8d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7d.
Wire	7d.
Rolled metal	6½d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£	s.	d.
Standard cash	227	17	6
Three months	228	5	0
English	228	2	6
Bars	230	2	6
Straits	230	2	6
Australian (nom.)			—
Eastern	230	12	6
Banca	229	17	6
Off. av. cash, November	228	13	4 10/11
Do., 3 mths., November	228	16	0 3/11
Do., Sttlmt., November	228	13	10 8/11

SPELTER

	£	s.	d.
Ordinary	11	13	9
Remelted	13	0	0
Hard	10	10	0
Electro 99.9	14	7	6
English	12	15	0
India	12	0	0
Zinc dust	17	0	0
Zinc ashes	3	0	0
Off. aver., November	12	2	9¾
Aver. spot, November	12	0	0

LEAD

	£	s.	d.
Soft foreign ppt.	10	7	6
Empire (nom.)	11	12	6
English	12	10	0
Off. average, November	10	10	3 9/22
Average spot, November	10	8	7 7/11

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	10	0
Do., V.M. ex-whse.	23	0	0
Rods	26	10	0

ANTIMONY

	£	s.	d.	£	s.	d.
English	74	0	0 to	75	0	0
Chinese, ex-whse.				65	0	0
Crude						—

QUICKSILVER

	£	s.	d.	£	s.	d.
Quicksilver	11	2	6 to	11	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.
Ferro-silicon—			
25%	8	17	6
45/50%	13	0	0
75%	18	7	6
Ferro-vanadium—			
35/50	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	5/3 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£14	10	0
Ferro-tungsten—			
80/85%	3/- lb.		
Tungsten metal powder—			
98/99%	3/3 lb.		
Ferro-chrome—			
2/4% car.	29	15	0
4/6% car.	23	0	0
6/8% car.	21	12	6
8/10% car.	21	12	6
Ferro-chrome—			
Max. 2% car.	34	0	0
Max. 1% car.	38	15	0
Max. 0.70% car.	42	0	0
70% carbon-free	10d. lb.		
Nickel—99.5/100%	£200 to £205		
"F" nickel shot	£184	0	0
Ferro-cobalt, 98/99%	5/3 lb.		
Metallic chromium—			
96/98%	2/5 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0 to £11	5	0
76/80% packed	£11 15 0 to £12	5	0
76/80% export (nom.)	£9	15	0
Metallic manganese—			
94/96% carbon-free	1/2 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/64 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	15	0 to	2	16	0
Bundled shrngs.				2	7	6
Mixed iron and steel	2	10	0 to	2	12	0
Heavy cast iron	2	10	0 to	2	12	6
Good machinery				2	15	0
Cleveland—						
Heavy steel				2	11	0
Steel turnings				1	15	0
Cast-iron borings				1	5	0
Heavy cast iron				2	12	6
Heavy machinery	2	13	6 to	2	15	0
Midlands—						
Light cast-iron scrap				2	7	6
Heavy wrought iron				3	0	0
Steel turnings, f.o.r.				1	14	0
Scotland—						
Heavy steel				2	10	0
Ordinary cast iron				2	12	6
Engineers' turnings				1	19	0
Cast-iron borings				1	17	6
Wrought-iron piling				2	12	6
Heavy machinery				2	17	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	24	0	0
Brass	16	0	0
Lead (less usual draft)	9	10	0
Tea lead	7	0	0
Zinc	8	10	0
New aluminium cuttings	66	0	0
Braziery copper	19	0	0
Gunmetal	22	0	0
Hollow pewter	155	0	0
Shaped black pewter	115	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/-
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	12	6 to	9	15	0
Nut and bolt iron	7	10	0 to	8	0	0
Hoops	10	10	0 and up.			
Marked bars (Staffs) f.o.t.	12	0	0			
Gas strip	10	10	0 and up.			
Bolts and nuts, ¾ in. × 4 in.	14	0	0 and up.			
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	9	5	0 to	9	7	6
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)				8	12	0
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates	12	5	0 to	12	10	0
Hoops (Staffs)				9	7	0
Black sheets, 24g. (4-t. lots)				10	10	0
Galv. cor. shts. (,,)				13	0	0
Galv. flat shts. (,,)				13	10	0
Galv. fencing wire, 8g. plain				14	10	0
Billets, soft	5	10	0 and up.			
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	0	0 to	5	7	6
Tin bars	5	2	6 to	5	7	6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11d.
Rods	10d.
Tubes	13d.
Castings	10⅝d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7¼
To 15 in. wide	1/1½ to 1/7⅛
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8⅛
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	20/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/2 to 18/6
,,	28×20 ,,	36/4 to 37/-
,,	20×10 ,,	26/- to 26/3
,,	18⅞×14 ,,	18/6 to 18/9
C.W.	20×14 ,,	15/9 to 16/-
,,	28×20 ,,	33/6 to 34/-
,,	20×10 ,,	23/9 to 24/-
,,	18⅞×14 ,,	16/-

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.	£	s.	d.
Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	0	0 to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	0	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£30	0	0 to	£31	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.	
Dec.	19 ..	28	1	3	dec. 1/3
,,	20 ..	27	17	6	,, 3/9
,,	21 ..	28	6	3	inc. 8/9
,,	24 ..	28	7	6	,, 1/3

Electrolytic Copper

		£	s.	d.	
Dec.	19 ..	31	10	0	No change
,,	20 ..	31	5	0	dec. 5/-
,,	21 ..	31	10	0	inc. 5/-
,,	24 ..	31	10	0	No change

Standard Tin (cash)

		£	s.	d.	
Dec.	19 ..	228	2	6	inc. 2/6
,,	20 ..	227	15	0	dec. 7/6
,,	21 ..	227	12	6	,, 2/6
,,	24 ..	227	17	6	inc. 5/-

Tin (English ingots)

		£	s.	d.	
Dec.	19 ..	228	7	6	inc. 5/-
,,	20 ..	227	17	6	dec. 10/-
,,	21 ..	227	17	6	No change
,,	24 ..	228	2	6	inc. 5/-

Spelter (ordinary)

		£	s.	d.	
Dec.	19 ..	11	12	6	inc. 1/3
,,	20 ..	11	12	6	No change
,,	21 ..	11	13	9	inc. 1/3
,,	24 ..	11	13	9	No change

Spelter (Electro, 99.9 per cent.)

		£	s.	d.	
Dec.	19 ..	14	6	3	inc. 2/6
,,	20 ..	14	6	3	No change
,,	21 ..	14	7	6	inc. 1/3
,,	24 ..	14	7	6	No change

Zinc Sheets (English)

		£	s.	d.	
Dec.	19 ..	23	10	0	No change
,,	20 ..	23	10	0	,, ,,
,,	21 ..	23	10	0	,, ,,
,,	24 ..	23	10	0	,, ,,

Lead (English)

		£	s.	d.	
Dec.	19 ..	12	5	0	No change
,,	20 ..	12	5	0	,, ,,
,,	21 ..	12	10	0	inc. 5/-
,,	24 ..	12	10	0	No change

A COMPARISON OF SCRAP PRICES

Prices of Heavy Steel Scrap (Delivered) in the Principal Districts at the Beginning of Each Month in the Years 1929–1934.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Scotland—													
1929	3 5 6	3 7 6	3 12 6	3 15 0	3 15 0	3 15 0	3 15 6	3 16 0	3 17 6	3 15 0	3 12 6	3 10 6	3 13 1½
1930	3 9 0	3 7 6	3 5 0	3 5 0	3 0 6	2 15 0	2 12 0	2 10 0	2 13 3	2 10 0	2 10 0	2 10 0	2 17 3½
1931	2 7 6	2 7 6	2 5 0	2 5 0	2 0 0	1 17 6	1 17 6	1 17 6	1 17 6	1 15 0	2 0 0	2 2 6	2 1 0½
1932	2 2 6	2 2 6	2 0 0	1 17 6	1 17 6	1 17 6	1 15 0	1 15 0	1 12 6	1 13 0	1 12 6	1 15 0	1 16 9½
1933	1 15 0	1 17 6	1 18 6	1 18 9	1 18 0	1 17 6	1 18 9	2 0 0	2 2 6	2 5 0	2 7 6	2 8 9	2 0 7¾
1934	2 8 9	2 14 3	2 13 0	2 13 0	2 12 0	2 10 0	2 10 6	2 10 6	2 11 0	2 10 9	2 10 1½	—	—
North-East Coast—													
1929	3 0 0	3 2 6	3 3 6	3 3 6	3 3 6	3 5 0	3 5 0	3 5 0	3 5 0	3 6 6	3 5 0	3 3 6	3 4 0
1930	3 3 6	3 3 6	3 2 0	3 0 0	2 17 6	2 10 0	2 10 0	2 7 6	2 7 6	2 7 6	2 5 0	2 6 0	2 13 4
1931	2 6 0	2 6 0	2 5 0	2 5 0	2 2 6	2 0 0	1 17 6	1 17 6	1 17 6	1 17 6	1 17 6	2 2 6	2 1 2½
1932	2 0 0	2 0 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 12 6	1 15 0	1 17 6	1 15 10
1933	2 0 0	2 0 0	2 5 0	2 0 0	1 15 0	1 17 6	2 2 6	2 2 6	2 3 6	2 5 0	2 7 6	2 7 6	2 2 2
1934	2 10 0	2 16 0	2 10 0	2 7 6	2 7 6	2 10 0	2 9 9	2 10 0	2 10 0	2 10 0	2 11 6	—	—
South Wales—													
1929	3 8 6	3 10 6	3 15 0	4 0 0	4 0 0	3 18 0	3 17 6	3 17 6	3 15 0	3 15 0	3 12 6	3 7 6	3 14 9
1930	3 7 6	3 6 0	3 6 0	3 4 0	3 2 6	2 17 6	2 16 0	2 15 0	2 14 9	2 12 6	2 12 6	2 5 0	2 18 3½
1931	2 5 0	2 7 6	2 7 6	2 7 6	2 5 0	2 2 6	2 0 0	2 0 0	1 18 0	2 2 6	2 5 0	2 7 6	2 4 0
1932	2 6 6	2 6 0	2 5 0	2 2 6	2 2 0	1 19 0	1 17 6	1 18 6	1 18 0	1 18 0	1 17 6	1 18 0	2 0 8½
1933	2 0 0	2 1 6	2 4 0	2 3 6	2 3 6	2 3 0	2 5 0	2 5 0	2 8 0	2 10 0	2 10 0	2 10 0	2 5 3¼
1934	2 10 0	2 16 3	2 15 9	2 13 9	2 14 3	2 15 0	2 14 3	2 14 3	2 15 0	2 15 7½	2 15 6	—	—

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All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

CHANGE OF APPOINTMENT DESIRED BY CHIEF CHEMIST with many years' experience as Works Manager for well-known English firm, in charge of manufacture and application of all classes of Vitreous Enamels for domestic purposes and for the chemical industries. Expert in enamel manufacture and design of plant.—Box 988, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVES required througnout Great Britain for marketing chemical device applied by metal and iron founders. Liberal commission only.—Write, Box ZX 175, c/o DEACONS, 5, St. Mary Axe, London, E.C.3.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY Foreman requires position. Excellent experience with high-class work, inciuding repetition work and moulding machines. Metal-mixing. Accustomed to modern foundry plant, estimating and costing. (251)

STEEL-FOUNDRY Chemist and Metallurgist desires change. Also had steelworks experience. Thorough knowledge electric-furnace practice, alloy steels, heat-treatment. (252)

MACHINERY

FOUR Osborn Jolt Press Moulding Machines, Type J.75, in perfect condition, cheap.—Write: ALEX. HAMMOND, Foundry Machinery Merchant, 14, Australia Road, Slough.

FOR Sale, 10-ton Morris 3-motor Travelling Crane, span 17 ft. 7¾ in., £80. 7½-ton Overhead Hand Travelling Crane, 16 ft. 6 in., £30. Both delivered any station. Acceptance and inspection at South Bank.—Apply, E. HIND, Imperial Works, South Bank.

MACHINERY—*Continued*

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.

100 cub. ft. AIR COMPRESSOR, 100 lbs. press., 800 revs., by Reavell; port.; petrol engine; 17" dia. flywheel.

Pneu. HAND DRILL; exhaust control blowing arrangement; hex. chuck 3¼" x ⅞"; 6 sets plugs and feathers.

4 MARINE BOILERS, 14' x 12', 180 lbs. w.p.

BABCOCK W.T. BOILER, 160 lbs. w.p., 5,540 sq. ft. heating surface.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MISCELLANEOUS

TRY our IRON CEMENT, WAX CORE VENTS and PARTING POWDER. "The right articles at the right prices"—carriage paid and quick despatch!—WM. OLSEN, LIMITED, 68, Cogan Street, Hull.

Phone: 4044.

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Pattern Maker to Engineering and Motor Trades.

PRIORY STREET, COVENTRY.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1934 edition. Price 42s. cloth bound, 52s. morocco. Order *YOUR* copy *NOW*.—INDUSTRIAL NEWSPAPERS, LIMITED, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

MOULDING MACHINES

406 OSBORN jolt rollover.
18"×36" TABOR rollover shockless (portable).
40"×30" TABOR rollover shockless.
TWO BRITANNIA No. 1 jolters.

HAND Machines taken in part payment for above or exchanged.

EXTENDED PAYMENTS ARRANGED.

SANDBLAST PLANTS

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories.
T.B. 4 Tilghman sandblast barrel plant, complete. Size of barrel 60" × 40".
T.B. 1 Tilghman sandblast barrel.
Small Tilghman rotary table sandblast.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun and on occasions—be it admitted—of naughtiness.

Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice-Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception.

Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received.

Here's a suggestion. Your eyesight is worth 3d a year to you. Send Peter and his handicapped pals 3d for every year you've had it. Now, please, in case it slips your memory. Good idea?

The Chairman,
SCHOOL FOR THE BLIND
(Founded 1838)
SWISS COTTAGE, LONDON, N.W.3

CORE OVEN.

THE "PORTWAY"

PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex.

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it.

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director.

Makers—

C. PORTWAY & SON, Tortoise Stove & Portway Portable Oven Works, **HALSTEAD, ESSEX.**

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OPEN HEARTH REFINED
REFINED CUPOLA
WEST COAST HÆMATITE

Also **SEMI-PHOSPHORIC**
for Motor Cylinders, Valve Bodies, Steam and Hydraulic Castings, Etc.

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From—
Brass, Gunmetal and other Copper or Nickel Alloys. Removes all traces of Aluminium.
INEXPENSIVE.
Sound Castings poured with a loss of few minutes only.
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ALL GRADES, IN POWDER, OR LUMPS FROM STOCK.

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By N. F. BUDGEN, Ph.D., M.Sc. Describes the properties and applications of aluminium and its alloys, and the latest processes and methods used. Everyone interested in the industry from a commercial or a technical point of view will profit by reading this book. Illustrated. **15/- net.**

METALLURGY OF BRONZE
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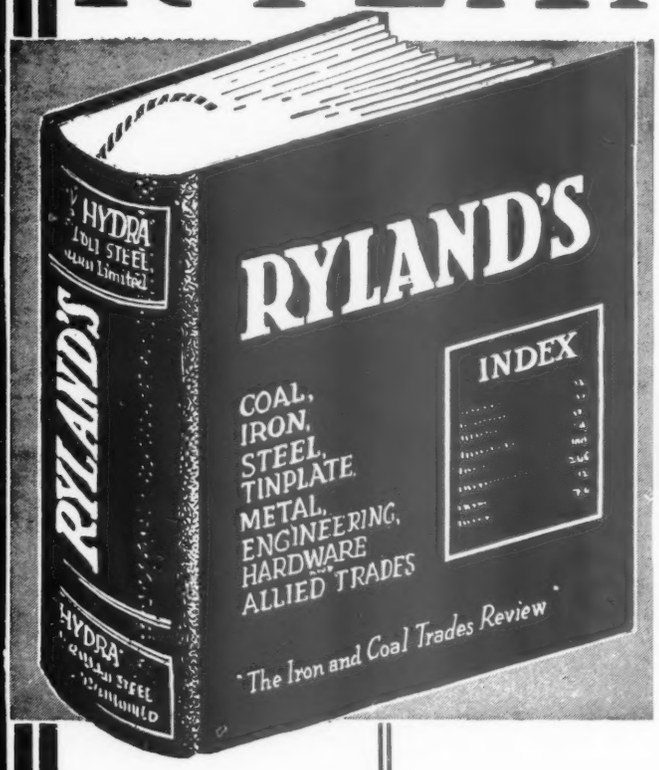

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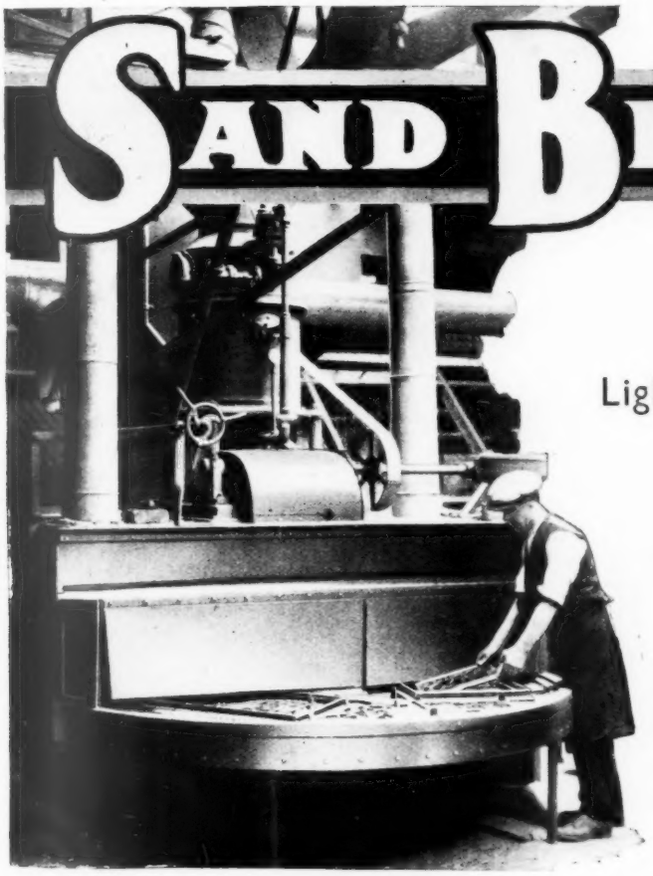

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